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Annual Report

For the Fiscal Year Ending November 30, 1940

The main purpose of this report is to provide an opportunity for presenting in published form, recent results from experimentation in fields or on projects where progress has not been such as to justify the general and definite conclusions necessary to meet the requirements of bulletin or journal.

MASSACHUSETTS STATE COLLEGE
AMHERST, MASS.

MASSACHUSETTS AGRICULTURAL EXPERIMENT STATION

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ANNUAL REPORT OF THE MASSACHUSETTS AGRICULTURAL EXPERIMENT STATION — 1940

INTRODUCTION

F. J. Sievers, Director

Research, as first inaugurated in our agricultural experiment stations, had as its primary, if not its sole, objective a direct service to the farmer in the development of a more efficient production of agricultural products. While this objective appealed to the imagination of those delegated the responsibility of directing the activities of the experiment stations, its interpretation required modification so that the program of investigation could include also the problems of the farm home and, more recently, the problems of the entire consuming public where these problems were related to or influenced by the products of agriculture.

In the last several years, and especially during the period of depression when the nation was confronted with several paradoxical situations in its economy, it became evident that a critical evaluation of all public service agencies was in order. As a result of such a study the conclusion became self-evident that, while the problems over which the farmer could and might exercise control had been quite adequately served, there was not the same organized interest in serving the agricultural industry as a whole. With this study came a realization that the problems of the agricultural industry were not the concern of the farmer solely but were more especially a matter of public concern, and that some public agency was needed to give these problems emphatic and intelligent consideration. For this service the state agricultural experiment stations were naturally considered best qualified.

The acceptance of this responsibility, however, will affect not only the extent but more especially the nature of the work. By degrees, this change in service will be reflected in the projects which furnish a basis for these Annual Reports. Not only will experiment stations hereafter be required to furnish the technical or experimental evidence essential to the solution of problems of the farmer; they will need to become the source of that leadership which will keep the agricultural industry on a sound basis. The experiment stations should be relied upon to furnish the protection necessary to make sure that the practices developed on the farm in the interest of profit, or even of subsistence, are not operating to the detriment of the agricultural industry or the permanency of agricultural production, because it is recognized as unsound to depend upon the farmer in a matter of such wide general interest.

It is hoped that this report may contain some evidence that the Massachusetts Station is taking this new responsibility seriously.

DEPARTMENT OF AGRICULTURAL ECONOMICS AND FARM MANAGEMENT

A. H. Lindsey in Charge

Enterprise Relationships and Farm Organization on Selected Farms in Massachusetts. (C. R. Creek.)

Costs and Returns of Growing Beans for Canning in Massachusetts. Supervised records of costs and returns were kept by 22 of the 54 farmers who grew green and wax canning beans for the first time in 1940. Acreage was contracted with each grower and the price established at $2.50 per hundredweight for grade A beans and $1.00 per hundredweight for grade B. These 22 growers had 10.75 acres of wax and 30.9 acres of green pencil pod beans, which yielded 2371 pounds and 4528 pounds per acre, respectively. For all the farms that kept records, 82 percent of the wax beans and 80 percent of the green beans were grade A. Since price was determined entirely upon grade, the wax beans were delivered for $2.227 and the green beans for $2.196 per hundredweight or $2.20 for all beans.

Cash costs included expense for seed, fertilizer, lime, dust material, rent, taxes, tractor and truck fuel, and hired labor for growing and harvesting. Family labor at 20 cents per hour and 20 cents per bushel for picking, and use of horses and machinery were added to these expenses to obtain total or farm costs for the enterprise. For all farms the cash cost was $74.75 per acre, $1.88 per hundredweight of beans, or 49 cents per bushel. The farm cost was $83.70 per acre, $2.11 per hundredweight and 55 cents per bushel. On 18 of these farms there was a net gain over cash costs, ranging from $1.31 to six cents per hundredweight; but only nine farms showed a gain over total farm costs, which ranged from 70 to 10 cents per hundredweight. Two farms had very large losses in cash and farm costs because of high growing expenses and low yields.

The seven farms that had the lowest costs per hundredweight of beans had much greater yields of higher quality beans on a larger acreage than the seven farms with highest costs. Farm cost was $1.84 and $3.22 per hundredweight and cash costs $1.75 and $2.52 respectively for these two groups. The low-cost farms showed a gain of 37 cents per hundredweight or $18.85 per acre over farm costs and 46 cents or $23.20 gain over cash costs. The bean enterprise was a losing proposition on the seven high-cost farms, with a cash loss of 40 cents per hundredweight or $8.50 per acre or a loss of $1.10 per hundredweight or $23.40 per acre when total farm costs were charged. Failure of the wax bean crop, low yields, and poor quality were the chief reasons for the losses on these farms.

Beans can be grown for canning in Massachusetts despite high labor and land costs if the farmer knows how to grow beans. The net return per acre will be smaller than in a year of good market prices, but a return is guaranteed by the contract if the beans can be grown for less than the established price. Commercial vegetable growers on large farms produced these beans for a profit in 1940 although many small growers lost money.

Grass Silage on Massachusetts Dairy Farms. The most common use of grass or hay silage in 1939 was to supplement summer pasture during the drouth in July and August. It was also used instead of green feed in the summer, as a supplement to corn silage in winter feeding, and in place of corn silage on some farms. Records on 72 farms throughout the state showed that 10,600 tons of molasses silage were made from 1477 acres of

various crops with a yield of 7.2 tons per acre. This silage was fed to 3994 cows at the annual rate of 2.6 tons per cow.

Mixed clover, alfalfa, and grasses were cut on 18.6 acres per farm for 31 farms to make 38 percent of the grass silage produced on these farms. Legume hay (clover and alfalfa) was cut on 23 of the farms with 14 acres each to make 22.5 percent of the total volume. Oats, wheat, rye, and barley were harvested green for silage on 37 farms with only 7.5 acres per farm to make 18.7 percent of the grass silage production. These small-grain crops were combined with vetch and peas, or millet and sudan grass with soybeans on 19 farms for 12.5 percent of the total tonnage from 9.5 acres per farm. Perennial grasses and millet and sudan were a small proportion of the entire crop although the yield of the two latter crops was highest at 8.5 tons per acre. Legume hay and mixed hay produced over seven tons of silage per acre, with some farmers obtaining as much as 10 tons.

Grass silage was made chiefly on institutional farms and the larger private dairies where special loaders and blowers could be purchased. On 15 farms both items were purchased at a total cost of $600 while other farm operators bought cutters at $425 or loaders at $170. The special grass cutter and blower was considered by these dairymen to be more essential to efficient operation than the grass loader.

Most frequently mentioned advantage of grass silage was the fact that unfavorable weather caused no delay in putting up the crop. Milk production was maintained during the summer of 1939 by feeding grass silage, and some dairymen stated that production was increased over corn silage in winter feeding. Other points which were mentioned were less waste in coarse first cutting of grasses, higher quality hay from second crop, continuous use of land with a rotation of annual crops for grass silage, less expensive than green feed and more uniform distribution of labor during the summer when grass silage was produced.

Some disadvantages had to do with poor quality of feed because the grass was cut too late, and disagreeable odors from the molasses silage which were probably due to spoilage because insufficient molasses was used. Extra help and special equipment costs were other drawbacks.

Vegetable Farming in Bristol County, Massachusetts, in 1939. (Norman R. Urquhart—in cooperation with the Bureau of Agricultural Economics of the United States Department of Agriculture.) Cash expenses of growing vegetables and operating the farm business used up all the cash income from sales of produce and other sources on 22 commercial vegetable farms in Bristol County for the 1939 crop year. Low yields and low prices combined to make this one of the most unprofitable seasons in recent years. Adjustments in inventories and the charge for family labor produced a $300 loss per farm in farm income. Interest on investment increased the loss to $692 in labor income.

One-third of the farms that were the most profitable had a net cash return and farm income of more than $1000 per farm and a labor income of $485. However, the seven farms with greatest losses had cash expenses of $1080 more than receipts. The acreage of vegetables per farm was almost equal in these two groups, but the yield of all crops was 16 percent larger and prices were 11 percent higher on the more profitable farms. Labor cost was higher per acre on the latter farms because of harvesting work, but labor return was 22 cents per hour compared to three cents on

the unprofitable farms. The average labor return for all farms was only 10 cents per hour. In 1939, the farms that made money produced several kinds of vegetables. This probably reduced the loss from the four or five very unprofitable crops in this area. Ten diversified farms with dairy and poultry enterprises in addition to vegetables and potatoes showed net returns that were much greater at $1453 per farm. Of this, $1157 was income from the livestock enterprises above feed and replacement costs.

The ten most important vegetable crops on the basis of total acreage on these commercial farms were sweet corn, tomatoes, iceberg lettuce, green beans, peppers, celery, spinach, cucumbers, cabbage and wax beans. These ten crops occupied 82 percent of the total acreage and accounted for 80 percent of total vegetable sales.

For the crop year 1939, 13 of the 22 commercial farms had greater cash incomes than cash expenses of operating the farms. Four farms had over $1000 of net cash return which ranged from a high of $2342 to a loss of $4432 for all farms. On 10 farms, after family labor and depreciation were charged, the farm income was greater than expenses. Only six farm operators had a labor income as payment for their labor and management of the farm for the year.

Suggested farm plans for the reorganization of three low-income market garden farms have been prepared. Small fruits, strawberries and raspberries, have been substituted in the crop plan for the vegetables which were most unprofitable. A small poultry enterprise has been added to the farm business for the period from October through March to provide additional farm income. Plans were also made to increase the amount of family living from the farm through the crop and livestock enterprises.

These plans were made in an attempt to appraise the recommendations of the Rural Policy Committees on the basis of facts obtained in the economic analysis of these farms. The present crop and livestock systems were compared with the suggested systems to show the effects of the recommended changes in the choice and combination of enterprises. The plans cannot be evaluated here since they have not been entirely completed or approved.

Labor Saving Methods and Techniques on Vegetable Farms. (C. R. Creek and Richard Elliot.) Data were obtained on the time required to harvest and pack early iceberg lettuce on 10 farms in the Dighton area in June 1940. The most common method of harvesting consisted of two operations: cutting and trimming the heads; and packing into crates in the field. Each cutter usually took three rows, cutting all heads that were ready and placing them on the stump of the plant with the butt end up. Then the heads were packed into crates by other workers who followed the cutters. A crew of five men on one farm cut 22 crates (18 heads) of lettuce per hour per man. This lettuce was packed at the rate of 28 crates per hour for each packer.

In another system of harvesting lettuce two men cut and trimmed heads which were tossed to the packer who kept a crate nearby. Four crews of three men cut and packed 16 crates of lettuce per hour per worker. The fastest crew did 20 crates and the slowest did 13 crates per hour. A third system was used where one man cut and packed the heads in one operation. A small crew of two men cut and packed 17 crates each in an hour on poor cutting.

Packing-shed operations were of two types: one where the packed crates

were washed, paper and ice applied, and slats nailed on; and the repack system, where heads were packed into crates after being brought from the field in flat boxes. The most efficient packing-shed system was a line where packed crates were washed in a tub under a spray, removed to a table and ice applied, then pushed along and paper put on, after which the slats were nailed on the crates. In these operations on iceberg lettuce the work was done more efficiently where each man had a particular job to do or where the principle of division of labor was applied.

Methods and techniques in harvesting and packing tomatoes were studied in five market areas. Trellis tomatoes that were sold in baskets on the Boston market were picked and packed with less effort and in less time than the ground type of tomatoes in one-half boxes for the same market. In other areas trellis tomatoes were sold in bushel boxes, one-half boxes, and fruit baskets. Time required for packing varied greatly according to quality of the tomatoes, method of packing, layout of the packing shed and individual differences in workers. Here again, the "line system" was most efficient, the tomatoes being run out on an endless belt from the wiping machine and packed by workers stationed on both sides. Packing from boxes or from trays was generally slower and more tiresome than the "line system."

Celery harvesting in the field and packing shed operations were checked again in 1940. Many of the farm systems which were studied in 1939 have been rearranged and the celery was bunched and packed more rapidly this year. Harvesting and packing of carrots, cabbage, and cauliflower were studied on one or more farms to determine more efficient and easier methods.

Competitive Factors Influencing the Supply of Market Milk and Cream in Massachusetts. (A. A. Brown, J. Elizabeth Donley, and Mabelle Booth.) Attention during the past year has been devoted to refining the information on the density and location of production in the Springfield milkshed and preparing the manuscript for publication.

The shed was divided into fourteen areas or sections within which marketing characteristics were similar. Total production in these areas ranged from an average daily volume of 3,578 pounds to 18,136 pounds, a ratio of about 1:5. Since this difference might have been due to differences in the size of the areas, total production was reduced to pounds per square mile, or density of production. Here there was a range of from 34 to 180.9 pounds, with a ratio of 1:5.3 between the lowest and the highest density. This variation in density of production was attributed to variation in two factors: the density of farms (per 10 square miles) within the area and the average size of farm in each area. A correlation analysis showed that density of farms was about twice as significant as size of farm in explaining variation in density of production.

Simplified, the shed is made up of several geometric figures. The main area is a triangle with its base in northern Connecticut and its apex in Sunderland, Massachusetts. On the right side of the triangle is a square including the Gilbertville, Ware area. To the northwest is a non-adjoining broad arc-shaped belt. In addition to these sections is a rectangular one in southeastern Vermont and an irregular one just over the Massachusets line in eastern New York.

The extremes in production were in the arc-shaped belt; to the lower left in the Berkshire Hills, deliveries per day per dairy were small, 125–

128 pounds; in the center and to the upper right they were relatively large, 226–287 pounds. Comparatively high production was characteristic also of the square on the right of the triangle, 220–224 pounds. A scale of production, intermediate to the extremes, was characteristic of the belt contiguous to and surrounding the market, 190–214 pounds. Production in the angles of the triangle tended to average about the same and was moderately light, 162–169 pounds.

An Analysis of Selected Merchandising Practices in the Fruit and Vegetable Industry. (A. A. Brown, Sargent Russell, and Mabelle Booth.) A study of apple prices on Washington Street Wholesale Market was made for 1934–35 and 1935–36. In studying the relationships between various factors which supposedly affect wholesale apple prices in New York City, no significant relationship was found other than that which existed because of normal seasonal variations of the factors. Stating it another way, when the normal seasonal variation was removed from the factors which affected price, no further relationships existed. The factors studied were temperature, weather (precipitation and degree of cloudiness), receipts (total as reported by Market News Service), and sales (figures for two companies from which records were obtained).

Correlations between price and temperature, weather, receipts, and sales without the removal of seasonal variation, were:

Temperature	.7427
Weather	.4284
(0 was clear)	
(10 cloudy or rain)	
Receipts	.8023
Sales	.6026

An investigation was also begun on the Cambridge Regional Produce Market. A study of this cooperative farmers' market was undertaken to determine the extent to which it has failed to come up to expectations; and the causes for such failure.

The degree of failure depends on the measure used. Certainly if one uses the regularity with which the market corporation has paid the interest on its obligations, the undertaking has failed 100 percent. If one uses the number of wholesalers and jobbers who have moved from the old market districts to the new as a measure of failure, the result is also 100 percent. If the degree of patronage by so-called large buyers—the chain stores and out-of-town jobbers—is the measure, the extent of failure is still complete. These premises were, however, the original ones upon which success was supposed to depend. In addition to them, of course, was farm patronage and in this quarter there has been both failure and success, and the achievements are all the more remarkable. Complete records during the first five years of the market are not yet available.

During the 1940 season for July 1 to October 25, inclusive, a period of 82 market days, 548 different farmers used the Cambridge Regional Produce Market. Only 36 of the total, however, were on the market for more than half the entire season. Equally extreme was the appearance of 183 users who sold on the market but once.

A preliminary analysis indicates that the majority of market users were small-scale farmers. They accounted for approximately 75 to 95 percent of the sellers on any one day, and had fifty packages on the load.

At the peak of the season on September 20, 140 farmers' trucks were on the market. The low point was on July 16 with 17 trucks. The market was most heavily patronized on Friday night, with the other days of the week in the following order: Monday, Wednesday, Thursday, and Tuesday.

DEPARTMENT OF AGRONOMY

Walter S. Eisenmenger in Charge

Tobacco Projects. (Walter S. Eisenmenger and Karol J. Kucinski.) It has been found that when plants of high lignin content are grown during the year preceding tobacco, the succeeding crop of tobacco is more likely to be affected by the so-called brown root-rot. The ligneous material, instead of being itself a specific cause of trouble, apparently encourages a class of decomposing organisms which are conducive to injury of the crop.

With the maturity of any seed plant the lignin content increases. During the past two years twelve different crops were sown at three different periods at about four-week intervals. The earliest plantings of these crops were completely ripe; the second, less ripe; and the third, still in the succulent stage when freezing weather came.

When tobacco was grown the following year on these variously treated plots, it was apparent that the tobacco grown after the completely mature crop was inferior to tobacco grown after the less mature crop, and the tobacco grown after the most immature plants was the best.

In another phase of this investigation tobacco was grown following a large number of plants. These various crops arrange themselves in the following descending order based upon the three-year average of the crop index of tobacco grown in rotation with them: sea weed (application), squash, horseweed, red top, ragweed, Jerusalem artichoke, gladiolus, carrots, sweet clover, buckwheat, cabbage, turnip, wheat, tomatoes, rye, Kentucky blue grass, millet, orchard grass, alfalfa, peppers, Sudan grass, sorghum, and red clover. In general the various crops ranked about as in other years in their effect upon yield and quality of tobacco.

The Lignin and Methoxy Content of Some Common Crops. (Walter S. Eisenmenger and John W. Hurdis.) It has been known for a long time that during the active period of decompositon of plant tissue containing large percentages of lignin, a retardation of growth and subsequent economic loss result with some crops. This presence of large quantities of lignin seems to interfere rather seriously with the tobacco crop.

Twelve different plants were chosen for study: Jerusalem artichoke, barley, buckwheat, corn, millet, oats, rape, rye, sorghum, Sudan grass, timothy, and tobacco. Samples were harvested at three different periods of maturity: first, when the crops were in a stage of rapid vegetative growth; second, when they were nearing maturity, being in the dough stage of seed development; and third, when they were mature.

As the plants approached maturity, there was an increasing carbon content, which, in conjunction with a decrease of total nitrogen, brought about a widening of the carbon–nitrogen ratio. With maturity, an increase in the methoxy content of the plants and in the methoxy content of lignin accompanied their increasing lignin content, while the total ex-

tractives and ash decreased. Those components which are most resistant to the action of bacteria and fungi are the ones which increase with maturity.

When tobacco followed these plants, the yields were lowest, both in quantity and quality, on those plots where the preceding crop had been allowed to mature.

The Absorption by Food Plants of Chemical Elements Important in Human Nutrition. (Walter S. Eisenmenger and Karol J. Kucinski.) If certain chemical elements are added to the soil in abundance, they are taken in by some kinds of plants in amounts larger that the normal growth and metabolism of the plants require. This is sometimes referred to as "luxury consumption" of elements. Other elements, however, are taken into the plants only in amounts needed. In this experiment, lettuce and cabbage were grown on a soil to which the cations, sodium, potassium, magnesium, and calcium, and the anions, chlorine, iodine, bromine, sulfate, and phosphate, were added separately to plots in quantities known to be far in excess of normal plant requirements, but not in sufficient quantity to be toxic.

The analyses show that the intake of all cations was substantially increased and that the increases of magnesium and potassium were greater than those of calcium and sodium. Thus, magnesium and potassium are much more nearly in the "luxury consumption" class than either calcium or sodium.

Phosphorus was increased in the roots about twice as much as in the tops, while the greatest increase of bromine and iodine was in the tops. Bromine and chlorine showed the highest percentage increases of any of the elements studied. Sulfur was increased substantially in both tops and roots of lettuce but not in cabbage. Cabbage is noted for its sulfur content; but sulfur is not a "luxury consumption" element, and the cabbage takes in only its normal amount regardless of the presence of an excess of the element in the soil.

The Intake by Plants of Elements Applied to the Soil in Pairs Compared to the Intake of the Same Elements Applied Singly. (Walter S. Eisenmenger and Karol J. Kucinski.) Results of other experiments have shown that the application of elements to soil tends to increase their quantity in the plant. In this experiment it was decided to study the intake by plants of elements added two at a time to the soil in quantities known to be excessive but not toxic. The materials used supplied calcium, potassium, and sodium at the rate of 250 parts per million of soil, and lithium at the rate of 100 parts per million. Lithium is exceedingly toxic; therefore it was added several months before seeding.

This study is in its initial stages, but analysis of cabbage, celery, and lettuce plants indicates that when sodium and calcium salts were applied together to soil, the calcium intake of the plants decreased. Similar results were obtained when potassium was added with calcium, but the percentage intake of potassium increased. Plants can tolerate lithium only in small quantities; but when potassium and lithium were added together to the soil, the intake of lithium was decreased. When cabbage plants were grown in soil treated with both potassium and sodium, the potassium intake was definitely decreased, which indicates that sodium can apparently replace potassium in plant nutrition.

Magnesium Requirements of Plants. (Walter S. Eisenmenger and Karol J. Kucinski.) Various species of plants have been grown on an area known to be deficient in magnesium. On the basis of foliar observation in the field it has been possible to separate the different species into two groups according to their apparent tolerance to magnesium deficiency. This classification is as follows:

Tolerant		*Not Tolerant*	
Alfalfa	Millet	Buckwheat	Pumpkins
Apple	Peas	Cabbage	Radish
Asparagus	Rhubarb	Cauliflower	Rape
Beans	Rye	Corn	Rutabagas
Beets	Soybeans	Cucumber	Spinach
Blueberries	Strawberries	Eggplant	Squash
Carrots	Sudan Grass	Grapes	Sunflower
Gladiolus	Sweet Potatoes	Mangels	Tobacco
Hollyhocks	Swiss Chard	Muskmelons	Tomatoes
Lettuce		Okra	Turnip
		Peaches	Velvet Leaf (*Abutilon avicennoe*)
		Peppers	
		Potatoes	Watermelon

Chemical analyses of the various plants have shown that when only magnesium was added to the soil all plants increased in magnesium, while their calcium content was generally decreased. Experience has shown that magnesium is more easily introduced into plant tissue than calcium when additional amounts are added to soil. When magnesium and calcium are added to the soil together, the intake of both elements may be decreased.

Calcium applications hastened the maturity of certain cucurbits. Determination of sugar in raspberries showed that magnesium applications tended to increase the sugar content while application of both magnesium and calcium produced raspberries with the highest sugar content.

The Relative Toxicity of Certain Ions and the Function of the Calcium Ion as an Antagonist as Indicated by Soybean Roots. (Walter S. Eisenmenger and Plese Corbett.) It has been recognized in agricultural practice that elements used to stimulate plant growth or as fungicides and insecticides may leave residues in the soil which tend to act as poisons to the plants if applied in sufficiently large quantities. However, if these same elements are applied in moderate quantities, they may be beneficial.

Seedlings were grown in single salt solutions of calcium nitrate, copper sulfate, lithium carbonate, manganese sulfate, magnesium sulfate, and zinc sulfate. Since the anions of these salts have been found not to influence growth to any appreciable extent, the cations are the factors to be considered. Each of the cations, Ca^{++}, Cu^{++}, Li^{+}, Mg^{++}, Mn^{++} and Zn^{++}, was found to be toxic in single salt solution; but the calcium ion in the form of $Ca(No_3)_2$ when placed with any one of the other single salt solutions overcame the toxicity of the medium to soybean seedlings. Over wide ranges of concentrations, the mixed solutions were less toxic than any of the single ion solutions.

Th Effect of the Calcium Ion on the Development of Soybean Seedlings and the Antagonism of This Ion to Arsenic, Boron, and Selenium Ions. (Walter S. Eisenmenger and Elvin T. Miles.) Farmers in certain regions have in recent years suffered partial loss of their crop because of relative scarcity of boron in the soil. This deficiency of boron was seemingly augmented by the addition of lime to the soil. It seems that when small amounts of boron are used on the soil to produce more normal plant growth the application of calcium will reduce the efficiency of the boron. This action of lime is not unlike that experienced when the calcium is used to overcome the toxic effect of overdoses of boron. Also in certain sections of the country the residues of arsenic from applications of sprays over a long period of time have been found to retard subsequent growth of annuals.

In an experiment designed to show growth of seedlings of soybeans in single salt solutions of boron, arsenic, and selenium, it was found that 1 p.p.m. of arsenic, 1.5 p.p.m. of boron, or 4 p.p.m. of selenium in aqueous solution produced a toxic reaction. In the presence of a neutral calcium salt, however, arsenic produced toxic effects only when the arsenic was present at the rate of 2 p.p.m. The toxic action of boron and selenium was also depressed by the presence of a neutral calcium salt. On the other hand it also holds true that the ions of arsenic, boron, and selenium will counteract the toxic action of single salt solutions of neutral calcium ions.

The Effect of Arsenious, Arsenic, and Antimony Oxides on Soil and Plant Growth. (Walter S. Eisenmenger and Hrant M. Yegian.) Pot culture studies under greenhouse conditions on the effect of arsenious, arsenic, and antimony oxides on Merrimac fine sandy loam and subsequent crop growth are being continued. Five successive crops, barley and buckwheat alternating, have been grown in the same pots during 1939 and 1940, and the lightest applications of arsenious and arsenic oxides (500 p.p.m. and 250 p.p.m. respectively) are still toxic to barley, and 1500 p.p.m. of arsenious oxide and 2,000 p. p. m. of arsenic oxide are toxic to buckwheat.

It was found that by returning sufficient amounts of buckwheat and barley tops to the pots arsenic toxicity could be overcome. A photograph of the fifth crop, buckwheat, grown in pots treated with arsenious oxide shows the value of organic matter in overcoming the arsenic toxicity very clearly. (Page 57.)

The antimony oxide treatment did not affect the yields of barley or buckwheat, and the soil was not injured even temporarily by the heaviest application (2000 p.p.m. antimony oxide).

Sunflowers and Their Possibilities. (Karol J. Kucinski and Walter S. Eisenmenger.) After the encouraging results obtained last year, the experiment was continued. Although the season was exceptionally late this year, sunflowers were planted on the 15th of May and grew to maturity, forming exceptionally large seed heads.

From the standpoint of seed production, fertilizer tests with sunflowers show that apparently they are not very heavy feeders. Doubling the application of fertilizer increased the yield of seed only about 5 percent. The best plots yielded about one ton of good seed to the acre. Seedings of one seed per hill every 18 inches in 36-inch rows proved to be better than two seeds per hill in 36-inch check rows. Two seeds per hill 18

inches apart produced very thin, weak plants which lodged so badly after wind storms that the crop was almost a complete failure. The two pictures on page 56 show comparative results obtained with the two systems of planting.

When sunflower plants were used for silage, as high as 19 tons per acre were obtained, comparing favorably with the yield of corn. If the sunflower plants were ensiled while their leaves and stalks were still green, cattle seemed to relish the silage and thrive on it.

Soil Conservation Research Projects. (Karol J. Kucinski and Walter S. Eisenmenger.)

A Survey of Erosion Problems Arising from Changes in Land Use. During the past year a detailed study has been made to find out whether the increasing potato acreage in Massachusetts has encouraged soil erosion problems. Many acres of old sod and pasture land have been plowed under within the past two or three years. Most of this new potato land is located on the sloping hillsides in the western part of Massachusetts. It is quite evident that this change in land use is resulting in the rapid decomposition of soil organic matter which has been accumulating for the past generation. The soil is exceptionally fertile at present and lends itself to large-scale field operations. If the potato crop is harvested very late in the fall and no cover crop is used, the soil erodes very readily with an appreciable loss of topsoil. It is felt by some that if this soil erosion is permitted to go on without any precautionary measures being taken for its prevention, the present high yields of potatoes cannot be maintained because of loss of organic matter and fertility of the top soil. It is deemed advisable, therefore, to encourage potato growers to practice soil conservation methods such as winter cover cropping and terrace and contour farming of their hillsides.

The Relation between the Rate of Wind Erosion and the Principal Factors Affecting it. In one phase of this investigation a detailed study was made of the wind erosion at the Cape. The sand areas found at the extremity of Cape Cod are approximately 6,000 acres in extent. Most of these areas, and especially those enclosing Provincetown Harbor, were originally forested but have been extensively devastated within historic time. As far back as 1714, and especially in 1826, extensive reclamation programs were initiated to stabilize these sand areas at the Province Lands. These early attempts were not too successful because woody plants were planted in the shifting sand without any previous introduction of beach grass to prevent the sand from moving away from the newly planted trees.

Today, various methods are used with great success in controlling the shifting sands and establishing permanent vegetative cover over the dunes. On very active sand dunes, branches of native pine are spread on the northwest side of the dune covering the "blow side" or "live side" of the dune. These branches act as a barrier which reduces the velocity of the wind and a shelter which catches beach grass seed. This beach grass seed, which is plentiful, germinates and the grass starts to establish itself during the next season. Not until the beach grass is well established is it desirable to make any tree plantings. Usually after two or three years the beach grass will spread itself sufficiently over the sand to prevent any further occurrence of serious "blow outs." When this stage has been reached, pine trees can be planted safely. It is the common practice to

plant in the early spring when there is plenty of moisture in the sand three- to five-year-old pine trees in rows about three feet apart in either direction. Various species, such as *Pinus sylvestris, P. mughus, P. austriaca,* and *P. rigida,* have been used effectively in establishing permanent cover over the dunes. The Austrian pine has been found preferable to the Scotch pine (*P. sylvestris*) for this region, since it seems to withstand the cold winters experienced at the Cape better than any other tree that has been tried.

In certain localities where the wind tends to blow out the embankments of roads it is expedient to sod with hog cranberry or beach grass a continuous strip two or three feet wide, parallel to the edge of the road. In some instances it has been found practical to spread a thick layer of native grass hay on the active wind-blown road embankments. This acts as a protective mulch for germinating the seed that is present in the hay or that is blown in.

Seeds of such native plants as sand peas, sumac, and Scotch broom, when sown broadcast on the sand in places where the wind is not too severe, germinate and produce a very desirable cover. To a lesser extent transplantation of bayberry shrubs can be useful in forming a protective marginal planting and windbreak where the wind has started to expose roots of previously planted trees. On the other hand, the beach plum, which is quite common, should not be encouraged since it is a host to many insects which are harmful to the more desirable types of trees.

The photograph on page 57, taken at Wellfleet, shows the characteristic way in which hog cranberry is adapted for controlling slope erosion on the sandy hills and roadside embankments at Cape Cod.

Trials with Improved Strains of Hay and Pasture Species. (W. G. Colby.) Nursery trials and small-plot experiments carried on for the last three years with several hundred strains of grasses and legumes indicate that some of these strains have definite merit and should be given wider trials over the state. Included in this group of superior plants are strains of Timothy, Orchard Grass, Meadow Fescue, Perennial Ryegrass, and Medium Red Clover.

Timothy. The following selections obtained from Professor Morgan W. Evans at Wooster, Ohio, gave superior performance:

F. C. 11,901: This is a very early-maturing strain, vigorous in growth, moderately leafy, and producing a good aftermath growth if weather conditions are favorable. It reaches the "bloom" stage about the 20th of June.

F. C. 15,167: This selection matures about a month later than F. C. 11,901. It is a dark green, leafy strain which produces a good yield of hay but not much aftermath.

Orchard Grass. The aggressive growth habits of orchard grass together with its early maturity have been some of the undesirable features which have hindered its more general use. The following improved strains have overcome, to some extent at least, some of these undesirable features.

Aberystwyth S. 37: This is a very leafy strain which produces a dense vigorous growth. Relatively few seed stalks are produced and these reach maturity about ten days later than the seed stalks of commercial strains of orchard grass. The use of this strain both in hay and pasture mixtures seems promising.

Finnish Commercial: A strain of orchard grass obtained from a com-

mercial seedsman in Finland shows promise as a hay type. It does not grow as tall as native commercial strains but it produces a dense, dark green growth, is much more leafy, and matures a week later.

Meadow Fescue. Svalöf's Early Meadow Fescue has been the most promising strain of this species. Although a little earlier than is desirable, this strain is the only one tested which thus far has shown a complete immunity to leaf rust. During the 1940 season the rust infestation on all other strains was severe and seriously affected the yield.

Perennial Ryegrass. Although perennial ryegrass may never become an important hay or pasture grass in Massachusetts, several of the strains tested were superior to those now available commercially. The strain O.A.C. No. 1 from Dr. McConkey at Guelph, Canada, and the strain E. F. 79 and Otofte from Denmark should be included in this group.

Red Clover. Of the many strains of medium red clover tested, three obtained from Dr. E. A. Hollowell of the U. S. D. A. grew particularly well. These were F. C. 22,655 (Central Corn Belt Blend), F. C. 22,586 (Illinois Red Clover), and F. C. 30,124 (Indiana Red Clover). A number of strains of foreign origin made a vigorous initial growth and suffered no winter injury but were severely attacked by leafhoppers. For this reason alone it was necessary to discard practically all strains of foreign origin.

Ryegrasses as Green Manure Crops. (Hrant M. Yegian and W. G. Colby.) The relative value of three varieties of ryegrass as green manure and winter cover crops following onions is being studied. The species which have been grown are briefly described as follows:

Domestic ryegrass (*Lolium sp.*) is a moderately winter-hardy species which is already being used as a cover crop by many vegetable growers. From 50 to 60 percent of the plants will survive the average winter; so unless the crop is completely turned under in the plowing operation, volunteer plants may interfere with the cultivation of the subsequent crop. If planted by the middle of August and plowed under by the first of October, from three-fourths of a ton to a ton and half of dry matter can be expected in the tops, depending upon the amount of available moisture and plant nutrients during this growing period. The tops together with the roots, therefore, add a considerable amount of organic matter to the soil.

Westerwolds ryegrass (*L. annum var. westerwoldium*) differs from ordinary domestic ryegrass in its strictly annual growth. It will produce about the same amount of growth as domestic ryegrass if planted by the first or middle of August. Being completely winterkilled, it will not produce any voluntary growth in the spring or interfere with subsequent crop cultivation.

Lolium subulatum, known as Wimmera ryegrass in Australia, is also an annual. It does not appear to develop as rapidly as the Westerwolds ryegrass, but the difference in growth is not great and it can be substituted for Westerwolds if the need arises.

The value of these ryegrasses as a green manure or winter cover crop depends to a large extent upon the nature of the soil and the weather conditions. One of these grasses, seeded at the rate of 30 to 35 pounds to the acre by the middle of August on land moderately high in fertility, with a moderate supply of rainfall, will produce a dense vegetative cover, and a considerable quantity of organic matter will be added to the soil.

Potato Variety Trials. (Ralph W. Donaldson, Walter S. Eisenmenger, and Karol J. Kucinski.) Based on yields, the ranking of potato varieties grown in plots at the college during the season of 1940 was Houma, Sequoia, Green Mountain, Sebago, Russet Rural, Earlaine No. 2, Chippewa, Irish Cobbler, Warba, Katahdin, and Mesaba. The average yield of all varieties mentioned was 50 percent more on plots sprayed twelve times than on plots sprayed only twice.

Downward Movement of Lime in Pasture Soils. (Arthur B. Beaumont.) In the spring of 1924 lime was applied as topdressing in two rates to certain plots used in a pasture experiment. In the fall of 1940, 16½ years later, samples of soil from these plots were tested for reaction. The results are as follows:

Depth at Which Sample Was Taken	Soil Reaction (pH) 16½ Years after Application of Limestone		
Inches	No Lime	3480 lb. per Acre	10360 lb. per Acre
0 - 4	4.5	5.6	6.9
4 - 8	4.7	5.1	6.6
8 - 12	4.7	5.3	6.0
12 - 16	5.1	5.6	5.6
16 - 20	5.3	5.6	6.1
20 - 24	5.5	5.8	5.9

The Effect of Fineness of Limestone on Soil Reaction. (Ralph W. Donaldson, Walter S. Eisenmenger, and Hrant M. Yegian.) How soon does liming become effective in sweetening soil and how do commercial lime products of varying fineness compare in this respect? These points are frequently raised by farmers and by lime manufacturers.

A preliminary study has been in progress eight months to observe what changes in pH are produced under a laboratory setup where commercial limes of differing fineness are applied to soil and results measured at frequent intervals by means of a Beckman glass electrode meter. Both limed and unlimed samples were kept in glass jars and maintained at optimum moisture conditions, with no plants being grown.

Five commercial grades of limestone, ranging from coarsely ground (50% through 60-mesh) to moderately finely pulverized (95% through 60-mesh), and one hydrated lime were thoroughly mixed with dry soil to furnish equivalent oxides and applied in three different rates—1½, 3, and 6 tons of (equivalent) limestone to the acre. These limes were compared on two Becket loams; one of initial pH 5.4 and the other a forest podzol of pH 3.6. Results obtained so far indicate:

1. With one soil (podzol), the sweetening effect of each lime was immediate and greatest at the first 10-day period of sampling. This condition remained fairly constant for about three months, after which differences between limed samples and the unlimed check decreased considerably.

With the other (less acid) soil, the initial change in pH induced by liming was also great; but after two months, in contrast with the other soil, differences between limed samples and the unlimed check tended in some cases to increase.

2. The finest lime (hydrated) produced the greatest change and the coarsest grade of limestone produced the least change in soil reaction. This distinction was measurable and consistent for these materials applied at all three rates and on both soils.

As would be expected, the three limestones of intermediate fineness produced changes of reaction between the two extremes. No consistent difference in effect was apparent between these intermediate grades except on one soil when they were applied at the 6-ton rate; then slight differences in soil reaction due to relative fineness of these limes became apparent.

3. Subsequent determinations made after an eight-month interval revealed varying rates of nitrate formation and accumulation, which increased the soil acidity. This was most pronounced where the finest limes had been applied, but occurred also to a marked extent in the check soil of initial pH 5.4 which at the end of the eight months had dropped to pH 4.3. If the nitrates had been removed from the soil solution by growing plants, the results might have presented a slightly truer picture of the effect of fineness of lime material in changing soil reaction.

Borax Trials on Alfalfa. (Ralph W. Donaldson, Walter S. Eisenmenger, and William G. Colby.) Borax, topdressed on 16 alfalfa stands in the state, and applied during November 1939 in strips at the rate of 25 pounds to the acre, controlled alfalfa yellowing on fields where it appeared after removal of the first crop of 1940. No yellowing was apparent in the early-season growth of the crop.

A yellowing of terminal leaflets, occasional bronzing, and more or less stunting developed on maturing plants of both the second and third growth of alfalfa located on approximately half the fields included in this investigation. These symptoms did not appear on the borax-treated strips, on which the plants stood out in contrast, showing better growth and normal color. These symptoms of boron deficiency did not develop during the early season when the rainfall was high but were associated apparently with the drier period of insufficient rainfall and later drought conditions prevailing until autumn frosts. Moreover, those fields which showed symptoms of boron deficiency were found to be predominantly those located on soils of the lighter texture (Merrimac). Little or no evidence of response to borax was observed this season on alfalfa located mostly on heavier soils, presumed to be of higher moisture content.

Symptoms of boron deficiency developed on plots of alfalfa which had received muriate of potash, 300 pounds to the acre, for three consecutive years. Since an application of borax corrected this trouble, it follows that muriate of potash in the amount applied did not correct a condition of boron deficiency in this case.

When borax (20, 30, 50, and 50 pounds to the acre) was applied in July at the time of seeding alfalfa and Ladino clover, temporary leaf injury and stunting of seedlings of both the legumes and weeds resulted at rates above 30 pounds to the acre. However, no injurious effect was observed the following season in character of stand or of growth from any rates of the borax applied. The soil was of limestone origin with pH around the neutral point.

COOPERATIVE TOBACCO INVESTIGATIONS

Conducted by the Bureau of Plant Industry, United States Department of Agriculture in Cooperation with the Massachusetts Agricultural Experiment Station.

C. V. Kightlinger, U. S. D. A., in Charge

Black Root-Rot. (C. V. Kightlinger.) Black root-rot is one of the most important diseases of tobacco in the Connecticut Valley. The project to develop new strains of Havana Seed which are more resistant to black root-rot and acceptable in type, yield and quality in the Connecticut Valley, is consequently being continued.

Selections from Havana No. 211 have been made to improve the strain. New strains have been produced by crossing strains of Havana Seed that are resistant to black root-rot with strains of common Havana Seed that are highly approved for type and quality. Selections from the progeny of these new strains and ther back-crosses are being tested.

Soil Treatments for Tobacco Seedbeds. (C. V. Kightlinger.) Damping-off diseases and weeds in tobacco seedbeds are important in tobacco growing in the Connecticut Valley. Treatments to control these troubles are consequently important.

Most of the large tobacco growers in the Connecticut Valley steam sterilize their seedbeds in the fall; a few steam treat their seedbeds in the spring. The practice of sterilizing tobacco seedbeds, however, is not so general in the Connecticut Valley as it should be. It is probable that more growers would sterilize their seedbeds if steaming equipment were not so expensive, or if other recommended methods did not cause inconvenience in application and delay in seeding. A method other than steam sterilization which would be effective, cheap, and convenient to use in controlling damping-off diseases and weeds in seedbeds, would mean much to the tobacco growing business in the Connecticut Valley.

Seedbeds which have been steam sterilized in the fall sometimes develop damping-off troubles because of subsequent contamination. Carelessness on the part of men working around the seedbeds may cause a large part of the contamination; but wind-blown earth, which is fairly common in the Connecticut Valley during the winter and spring of most years, is responsible for a considerable part of the contamination. Supplementary spring treatments for seedbeds steam sterilized in the fall, which would be effective against damping off, cheap, and convenient, would be a valuable aid.

Experiments were begun in the fall of 1940 to test the effectiveness of certain other treatments in comparison with steam sterilization, to control damping-off diseases and to kill weeds in tobacco seedbeds. The experiments include both fall and spring treatments. Preparation for the test was begun a year earlier by maintaining a seedbed to which earth infested with damping-off organisms obtained from seedbeds in various places in the Connecticut Valley, was applied during the spring and summer, to assure the presence of various types of damping-off organisms. Tobacco seedlings were grown from time to time in the seedbed throughout the spring and summer to increase the supply of damping-off organisms. Damping-off of tobacco seedlings was occurring in this seedbed when the soil was worked to prepare it for fall treatments of the experiment.

Overwintering of Common Tobacco Mosaic Virus in Soil Under Natural Conditions. (C. V. Kightlinger.) This project has been completed. The purpose was to determine whether common tobacco mosaic virus could overwinter in soil under natural conditions in the Connecticut Valley, and if so, then to determine how much mosaic would develop in succeeding tobacco crops with the overwintered virus as a source of inoculum. By way of summary of experimental results, it may be stated that the mosaic virus overwintered abundantly in the soil but that only a small percentage of the tobacco plants grown on the land developed mosaic.

DEPARTMENT OF ANIMAL HUSBANDRY

Victor A. Rice in charge

The Effect of Complex Mineral and Vitamin Mixtures on Milk Production, General Health, and Reproductive Efficiency in Dairy Cattle. (J. G. Archibald.) This project was completed during the past year. A confidential report was furnished to all interested parties, but release of the results in a general publication is not contemplated. No benefits from the feeding of two of the three complex mixtures investigated over a two-year period, were in evidence. Slight positive results were obtained from the third supplement fed. The following paragraphs are quoted from the confidential report on this particular supplement:

Although only one, or possibly two, of the differences between the groups of cows are of significance, nevertheless the general trend of the evidence slightly favors the group which received the supplement. These cows maintained their general condition slightly better than the controls did; they gave slightly more milk (1.4 lbs. daily); they required a significantly smaller number of services to get them with calf; and they had somewhat less trouble at calving time with retained afterbirth.

It is impossible, of course, to say definitely whether the supplement as a whole produced this desirable effect, or whether it was due to some one ingredient of what was a rather complex proprietary mixture, and, if the latter, what particular ingredient. It is our opinion, however, that the ingredient most likely to have been responsible for the slight benefits noticed was the cod liver oil the supplement contained. Results of a somewhat similar magnitude and trend were obtained a few years ago in an extensive trial of the merits of a cod liver oil concentrate added to the grain mixture for about half the milking herd of cows at the Massachusetts State College.

It seems probable that the price of the supplement (9 cents a pound at the time it was purchased in 1936) would prohibit its use by the average farmer. Fed at the rate of two percent of the grain mixture, it would add $3.60 to the cost of each ton of mixed grain. If, as we believe, the beneficial effect of the supplement is due to the cod liver oil it contains, sufficient cod liver oil concentrate to furnish 30,000 additional U. S. P. units of vitamin A per cow daily (an amount that along with the potential vitamin A in average quality roughage provides a reasonable margin over requirements) can be purchased for not more than $1.00 of additional cost per ton of mixed grain.

A Study of the Mineral Elements of Cow's Milk. (J. G. Archibald and C. H. Parsons.) For reasons outlined in last year's report, the work

with iron in milk was repeated during the winter of 1939–40. In the earlier work done in 1938–39 only about as much supplemental iron was fed daily as calculation showed to be already present in the ration. In this more recent work from 3 to 4 times as much iron was added as occurred naturally in the ration; as before, the supplement was the readily soluble iron ammonium citrate.

Results were very variable, with no definite trend. Average amounts of iron were of the order of 0.3 mg. per kilo of milk or less, somewhat less than was found in the earlier work, due it is thought to refinements in method. As before, differences between individual cows in the same group or between samples from the same cow in different months were much greater than the average differences between the group receiving iron and the group that did not receive it. Irrespective of method of statistical handling of the results these average group differences were not significant. It is therefore concluded that the iron content of cows' milk cannot be consistently changed by feeding an iron supplement. Workers in other experiment stations have reached this same conclusion but with smaller numbers of cows and over shorter periods of time. The element manganese is being studied this year.

Investigation of the Merits of Legume and Grass Silage for Massachusetts Agriculture. (J. G. Archibald and C. H. Parsons.) Further work was done with phosphoric acid silage during the winter of 1939–40. In double reversal feeding trials with fourteen cows over a period of 3½ months, practically the same amount of milk was produced on this type of silage as on corn silage (39.30 lbs. daily per cow as contrasted with 39.35 lbs. daily per cow). However, the observations in last year's report regarding palatability and gains in live weight have been confirmed. Phosphoric acid silage was somewhat less palatable to cows than either corn silage or molasses silage, and gains in live weight were practically negligible when it was fed. Again this year phosphoric acid silage has produced milk of a finer flavor than that from cows on corn silage.

Our first extensive trial of the suitability of molasses grass silage for growing dairy heifers was made during the past winter in comparison with corn silage. In a double reversal trial 12 weeks in length, 18 heifers gained 7.3 percent in live weight when fed corn silage, and 6.3 percent when fed molasses grass silage. Average grade for condition, based on general appearance and handling was:

On corn	Good+++
On grass	Good+

The molasses silage was readily eaten by the heifers.

Results of this trial coupled with small weight gains noted when this type of silage is fed to milking cows lead us to the tentative conclusion that grass silage is better suited to milk production than to laying on of flesh.

A study of Urea as a Partial Substitute for Protein in the Ration of Dairy Cows. (J. G. Archibald.) This project was organized the first of the year in cooperation with the E. I. DuPont de Nemours Company of Wilmington, Delaware, and the Massachusetts State Department of Mental Health. Twenty-four cows in the herd of the Medfield State Hospital are included in the feeding trial, eight of them on a double reversal plan with periods eight weeks in length, and the other sixteen on a continuous feeding plan, eight to receive the regular herd ration for two

complete lactations while the other eight receive a grain mixture in which urea has been substituted for the usual protein concentrates (cottonseed meal, soy bean oil meal, and gluten feed). The maximum amount of urea which it is planned to feed is 3 percent of the grain allowance (60 lbs. per ton). This amount has now been fed for over six months without untoward results. Cornstarch is being used to balance the energy content of the grain mixture which contains urea.

The first season's work with the eight cows on the double reversal experiment has been completed and summarized, and results from the first twenty-two weeks with the sixteen cows on the continuous feeding trial are also available. While final conclusions must await the outcome of another year's work, results to date indicate that, except for a slight superiority in the general condition of the cows receiving the regular ration, the two rations have had apparently similar effects.

The Effect of Feeding Irradiated Dry Yeast on Reproduction and General Health in Dairy Cows. (J. G. Archibald and A. E. Conklin.) This practice, established some years ago for the production of metabolized vitamin D milk, is being investigated for its possible beneficial effect on the cows themselves. The work is being done in cooperation with Standard Brands, Inc., of New York City and the Massachusetts State Department of Health. Sixty cows in the herd of the Gardner State Hospital have been divided into two groups, one of which receives the regular herd ration while the other receives in addition irradiated yeast (½ pound per ton of grain) for a period of two years. Careful records of milk production, reproductive function, and general herd health are being kept. The work has not yet been in progress long enough to yield any substantial amount of data or to warrant drawing any conclusions.

DEPARTMENT OF BACTERIOLOGY

Leon A. Bradley in Charge

Nitrification in Soils Containing Plant Residues of High Lignin Content. (James E. Fuller.) This experiment is being carried on in cooperation with the Agronomy Department. In 1939 a number of plots were planted with crops having high lignin content. For comparison, some low-lignin crops were planted, and some plots were left fallow. In the fall the crops were plowed under. In 1940 tobacco was grown over the whole area. Soil samples were collected in the spring, in mid-season, and in fall. The ability of the soils of the samples to nitrify their own nitrogen and to nitrify dried blood was studied. The experiment is based on the theory that if it can be shown that certain crops plowed into the soil hamper the process of nitrification, it might follow that growth of plants (tobacco, for instance) would also be interfered with; and stunted, or even diseased crops, would result.

To date, no differences observed in the nitrifying capacities of the soils can be attributed to the crops plowed under. The experiment will be continued another year.

Bacteriological Study of Spices and Spice Oils. (James E. Fuller and Frederick J. Wishart.) Several standard brands of packaged spices were studied, including cinnamon, cloves, nutmeg, allspice, black pepper, red

pepper, paprika, and mustard. The bacteria found were common airborne varieties (*B. subtilis* group) that are of no particular sanitary significance. Intestinal bacteria (coliform group) were not present. Bacteria of intestinal types and of types capable of causing food poisoning (coliform bacteria, Salmonella strains, and staphylococci) inoculated into the several spices did not survive for more than a few weeks. Some oils of the spices were investigated and found to be sterile when they were purchased. Some were found to have the power to inhibit bacterial growth. More work will be done on this phase of the problem.

Effects of Temperature on the Differential Reactions of Coliform Bacteria. (James E. Fuller and Sonnia Levine.) The evaluation of the sanitary significance of certain members of the coliform group of bacteria in rural water supplies (springs and wells) offers some puzzling problems. The separation of definitely fecal strains from strains definitely of soil origin is relatively simple; but there are numbers of strains which give differential reactions between these two species, and the sanitary interpretation of the so-called intermediate strains presents the problems. Eijkman proposed incubating water-test cultures at 46° C., instead of at the usual 37° C., on the basis that the fecal strains would give positive tests for pollution (production of gas in lactose broth) at the higher temperature while other strains would not. In the present study the differential tests (Imvic reactions) of a number of intermediate strains were tried at several temperatures from 25° C. (room temperature) to 46° C. The evidence indicated that by this method certain of the intermediates could be placed in a group closely related to the fecal type (*Escherichia coli*). The indol test worked especially well in this respect.

Studies of Fecal Streptococci. (James E. Fuller and Robert S. Lubitz.) This study is a continuation of work previously reported (Fuller and Guiberson, Mass. Expt. Sta. Bul. 369, p. 20, 1940; France and Fuller, Amer. Jour. Pub. Health, 30 (9):1059-1062, 1940). In the bacteriological testing of swimming pool water, it is desirable to differentiate between fecal streptococci, and streptococci from the skin or from the nose and throat. The former would indicate pollution of the water from intestinal source, and the latter would indicate danger of skin or of respiratory infection to users of a pool.

In the study here reported an attempt was made to develop differential methods by the use of media of high pH value, or of high sodium-chloride content. Some information was obtained concerning the tolerance of fecal streptococci and of coliform bacteria to both high pH and high sodium-chloride concentrations in media. No successful differential procedure was developed.

Bacteriological Studies of Chocolate Syrups and Cocoa Powders Used in Chocolate Milk. (James E. Fuller and R. W. Swanson.) This study is being made in cooperation with W. S. Mueller of the Department of Dairy Industry. The work has been undertaken only recently, so only preliminary results can be given. The bacterial contents of the syrups and powders vary a great deal. There is little indication to date that the addition of either syrup or powder increases the bacterial counts of milk except for the addition of the bacteria present in the syrups or powders themselves. There is some indication that both chocolate and cocoa may have the capacity to hinder the growth of certain bacteria.

Studies of Methods for Determining the Sanitary Quality of Drinking Utensils. (Ralph L. France, W. E. Cassidy, and James E. Fuller.) Results obtained to date on this project are as follows: (1) The use of a wet swab on the glasses gives better results than a dry or a moist swab. (2) As a suspending medium and a diluting fluid phosphate water and saline were equally satisfactory. (3) A medium containing sodium chloride, yeast extract, neopeptone, and dextrose recovered more organisms than the standard plating agar. (4) All swabs should be iced immediately after collection if the elapsed time between sampling and laboratory testing is more than two hours.

The Streptococci Test as an Index of the Sanitary Quality of Drinking Utensils. (Ralph L. France.) A test for streptococci similar to that used in swimming pool sanitation might be used to determine the sanitary quality of drinking utensils. Results to date indicate that when a glass or cup has been improperly sanitized it is possible to obtain streptococci when the lip of the container is swabbed. In the case of a properly sanitized glass this is not possible. Further work of a practical nature will be carried on to add confirmation to these results.

Neisseria Catarrhalis as an Index of Pollution in Swimming Pool Water. (Ralph L. France.) The use of *N. catarrhalis,* an oral and nasal-passage organism, has been recommended as an index of pollution in swimming pool waters. A comparison of this method with the streptococci index and the coliform (Standard Method) index is being made. The results obtained to date suggest that the streptococci index is much more indicative of the actual sanitary conditions of a pool than is either of the other two methods. In fact, this writer has been unable, up to the date of this report, to isolate *N. catarrhalis* from swimming pool water by the method recommended.

Laboratory Service. (Ralph L. France.) Following is a list of the types and numbers of examinations made during the past year:

Milk (bacteria counts)	787
Ice cream (bacteria counts)	116
Water	150
Miscellaneous:	
Butter fats	2
Mastitis	2
Ropiness	1
Total	1,058

SUMMARY OF SERVICE BACTERIOLOGY—1928 TO 1940

Year (Sept. 1-Aug. 31)	Paid Examinations				No-charge Examinations				Total Examinations for the Year
	Milk	Water	Misc.	Totals	Milk	Water	Misc.	Totals	
		*23							
1928-29 ..	432	144	35	634	653	38	3	694	1,328
1929-30 ..	466	211	47	724	326	5	4	335	1,059
1930-31 ..	745	117	66	928	288	32	0	320	1,248
1931-32 ..	899	88	223	1,210	270	35	1	306	1,516
1932-33 ..	782	81	314	1,177	305	39	14	358	1,535
1933-34 ..	801	60	57	918	196	18	0	214	1,132
1934-35 ..	873	82	99	1,054	251	16	0	267	1,321
1935-36 ..	1,133	79	256	1,468	304	6	24	334	1,802
1936-37 ..	1,098	86	499	1,683	389	33	20	442	2,125
1937-38 ..	739	106	504	1,349	382	22	62	466	1,815
†1938-39 ..	595	118	410	1,123	418	5	25	448	1,571
†1939-40 ..	438	130	178	746	465	20	15	500	1,246
Totals ..	9,001	1,325	2,688	13,014	4,247	264	173	4,684	17,698
Grand Totals (Paid and No-charge)	13,248	1,589	2,861						17,698

*Chemical analyses.

†This sudden decline in the number of samples (mostly milk) can be traced directly to the installation of several municipal and private laboratories in this part of the state.

DEPARTMENT OF BOTANY

A. Vincent Osmun in Charge

Diseases of Trees in Massachusets. (M. A. McKenzie and A. Vincent Osmun.)

The Dutch Elm Disease Problem. State-wide interest in the Dutch elm disease was intensified during 1940 as reports of affected trees in Columbia County, New York, and Litchfield County, Connecticut, established new stations for the causal fungus, *Ceratostomella ulmi* (Schwarz) Buisman, in areas immediately adjacent to the west and south of Massachusetts' boundaries, and the total number of trees found to be infected in the United States rose to 61,391. At the present time (December 2, 1940), no positive proof of the disease in the elms of Massachusetts has been established although hundreds of suspected trees have been checked in field and laboratory studies during the past year.

The work of the organized project of this Station in collecting and studying specimens from trees showing symptoms macroscopically indistinguishable from those of the Dutch elm disease has been supplemented by other public and private groups and individuals, including the Massachusetts Department of Agriculture, United States Department of Agriculture, The Massachusetts Forest and Park Association, town and city tree wardens, employees of other municipal and State departments, arboriculturists, and private citizens. Recently in cooperative investigations the Director of Plant Pest Control of the State Department of Agriculture has seen fit to invoke the provison of the Massachusetts statute for the destruction of trees infested with carrier insects of the causal fungus in two instances where elms were believed to be dangerously threatened by the disease. Connecticut, however, remains the only New England State in

which the presence of the Dutch elm disease has been definitely established, although a recent report in the eastern part of that State carries the disease to a point within ten miles of the Rhode Island line; and the presence of the disease in areas of infestation in New York near the Vermont line further threatens the elms of New England States other than Massachusetts.

During the past five years close surveillance of the elms in Massachusetts has revealed certain facts relative to the Dutch elm disease problem in Massachusetts. From time to time, considerable confusion has been encountered resulting from popular misunderstandings, of which the following is only one example. The necessity for accuracy in describing the disease as a result of infection by a fungus is frequently overlooked, and leaf beetles (which contribute to tree weakening) and bark beetles (which are believed to be the principal carriers of the causal fungus) are sometimes confused with the actual specific fungus disease. In practical application, however, the association of the various factors may not be far amiss if it is borne in mind that none of the factors which favor the development or spread of the disease can initiate the disease independent of the fungus which causes it. In a concise report[1] on this problem it was pointed out that the disease control program in the State has consistently worked toward the elimination of conditions which would be favorable to the establishment and spread of the disease within Massachusetts. Particular emphasis should be given to the reported danger from the carrier beetle (*Scolytus multistriatus* Marsh.) population in southwestern Massachusetts, which is continuous with the beetle population of the adjoining New York area where beetle-infested trees infected with the causal fungus have been found. The existence of a distinct area of infestation of this same carrier beetle in eastern Massachusetts has set the stage for the spread of the disease there if the causal fungus is permitted to be introduced and established widespread in the area, but obviously the elms of western and southwestern Massachusetts stand in more immediate danger because of the proximity of both the causal fungus and the carrier beetle.

The existence of a more or less natural barrier relatively free from elms in the southwestern corner of the State, together with the aggressive eradication programs for areas where the disease has been found may explain the delay in the spread of the disease to Massachusetts. Outside of Massachusetts, in programs for the eradication of the disease, 61,269 elms known to be infected with the disease fungus have been removed, in addition to 5,567,334 weakened or undesirable elms which have been removed because, as breeding places for carrier beetles or in some other way, they constituted conditions favorable for the spread of the disease. In Massachusetts, to the extent that municipalities are able to prevent the accumulation of elm material favorable for beetle breeding, a real obstacle to the rampant spread of the disease will be established.

If the fullest measure of benefit from the defensive campaign waged vigorously against the Dutch elm disease in the areas where the disease occurs outside of Massachusetts is to be realized, therefore, only a course of continued vigilance in an offensive and, if necessary, also a defensive campaign against the disease is open to Massachusetts.

[1] Osmus A. Vincent. The Dutch elm disease situation as it concerns Massachusetts. Published among "Transcriptions of Certain Papers presented at the Seventh Annual Five-Day Short Course for Tree Wardens and Foresters," M. S. C., March 30, 1940.

Other Tree Problems. Seventy-one fungus diseases of thirty-five species of trees or other woody plants, including twelve diseases of elm, were identified from more than 600 specimens and inquiries received during the year. *Cephalosporium* sp. was isolated from elms of 16 municipalities in which the wilt disease caused by this fungus was not previously known to occur, making a total number of 152 cities and towns in which the disease has been found in Massachusetts. The progress of the disease in individual mature trees was found to be far from uniform. In experiments also, trees subjected to controlled conditions were found to be affected in varying degrees following inoculation with the causal fungus. The latter observations suggest the significance of resistant individuals, while field observations suggest that additional factors involved in susceptibility include winter injury and drought.

Preliminary experiments on another wilt disease of elm, caused by *Verticillium* sp., showed more extensive injury to maples inoculated with the fungus, in pots under controlled conditions. The Verticillium wilt disease of elm is believed to be caused by the same fungus which causes the disease of maple known as Maple Wilt as well as other diseases resulting from infection of the water-conducting tissues in numerous additional plants. When elms and maples were inoculated with the fungus isolated from elm, the elms died back somewhat but never completely, while the maples were sometimes killed. The isolation of *Verticillium* sp. from trees of six municipalities in which the fungus had not been reported previously, increased to 77 the total number of cities and towns where the Verticillium wilt disease of elm is now known.

During the year, experiments and observations of a fungus, *Phomopsis Gardeniae,* as a cause of injury to gardenias were reported,[2] [3] including in one instance a review of previous publications on this fungus.

The sycamore disease, caused by *Ceratostomella* sp., reported in New Jersey and elsewhere has not been found in Massachusetts as yet although so far as is known, no organized search has been made here.

A disease of maple known as Bleeding Canker has aroused widespread interest throughout the State. The fungus, *Phytophthora cactorum,* has been described as the cause of this disease by F. L. Howard and N. Caroselli.[4] A fungus believed to be the same species has been isolated in laboratory studies made from collections of elm, maple, and beech in Massachusetts, but no specific experimental work has been undertaken by this Station. The problem is recognized as a serious one since remedial treatment of affected, highly prized specimen trees may be desirable. Meager experimental work and the paucity of published data have resulted in a demand that work be undertaken by public agencies on this problem. The whole subject of tree therapeutics as well as the highly speculative and much misunderstood practice of tree injection is involved in this problem, which demands more concentrated attention than can be profitably accorded to this research as a side line dominated by other major work. It is recognized, however, that the demand for investigation

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[2] McKenzie, Malcolm A., Jones, Linus H. and Gilgut, Constantine J. *Phomopsis Gardeniae* in relation to gardenia culture. Plant Disease Reporter 24:3:58-62. February 15, 1940. (Contribution No. 363.)

[3] McKenzie, M. A., Jones, L. H. and Gilgut, C. J. Study practical gardenia canker control as disease increases (illus.). Flor. Rev. March 28, 1940. (Contribution No. 367.)

[4] Phytopathology 30:11. 1940.

on this problem is legitimate even if it cannot be met under present conditions.

At the request of the Massachusetts Tree Wardens' Association a report entitled, "Mortality in street tree planting"[5] was prepared; and a paper entitled, "The tree warden and the town forest" was presented at the Fifth Annual Conference on Current Governmental Problems, November 15–16, 1940.

Investigation of certain injury to trees and other plants revealed evidence that sulfur dioxide fumes from an electric refrigerator had caused sudden if temporary damage.[6] [7]

Weather conditions of the early part of the 1940 growing season were particularly favorable for the spread of leaf-infecting fungi, and considerable injury to foliage also resulted in early summer from the burning of tender growth following foliage development. The period of dry weather previous to the freezing of the ground in the autumn of 1939 caused extensive injury to broadleaved and coniferous evergreens as well as less extensive injury to deciduous trees in certain localities.

Current miscellaneous activities of the project included the preparation of parts of the program of the Five-Day Short Course for Tree Wardens and the preparation of newspaper press releases.

Damping-off and Growth of Seedlings and Cuttings of Woody Plants as Affected by Soil Treatments and Modification of Environment. (W. L. Doran.) Sandy soil is proving to be a good rooting medium for cuttings of some species and a paper[8] was recently published on results obtained with it. Softwood, July, cuttings of *Styrax japonica*, *Cornus Kousa*, and Cornelian cherry treated with indolebutyric acid (12.5 or 25 mg. per liter for 18 or 20 hours) rooted 10 to 50 percent in sand, 70 to 100 percent in sandy soil. Untreated July cuttings of Pfitzer juniper rooted 100 percent in sandy soil, 83 percent and more slowly in sand; but hardwood, December, cuttings of that variety, after treatment (100 mg./l., 20 hr.), rooted better in sand. November cuttings of Gardenia rooted practically equally well in sand sterilized with hot water and in unsterilized sandy soil or sand–peat. Late fall cuttings of *Taxus media* and its variety *Hicksii*, treated with indolebutyric acid, rooted better in sand-peat than in sandy soil or sand, but untreated cuttings of *T. media* rooted 72 percent in sandy soil, 28 percent in sand. Similar cuttings of *Chamaecyparis obtusa* var. *filicoides*, untreated, rooted 57 percent in sandy soil, 28 percent in sand. November cuttings of *Picea glauca* var. *conica*, treated or not, rooted better in a mixture of sand, peat, and loam (3:1:1) than in either sandy soil or sand; best rooting, more than 90 percent, being of cuttings, treated with indolebutyric acid 50 mg./l., 18 hr.

Rooting of cuttings of white pine from mature trees has been considered difficult, but certain trees with unusually good characteristics from the viewpoint of the forester having recently been found here, their propaga-

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[5] McKenzie, Malcolm A. Published in "Proceedings of the Annual Meeting of the Mass. Tree Wardens' Assn.," February 7 and 8, 1940.

[6] McKenzie, Malcolm A., and Jones, Linus H. Injury to trees from sulfur dioxide fumes of electric refrigerators. Science 91:2358:239-240. March 8, 1940. (Contribution No. 358.)

[7] Sulfur dioxide gas damages foliage. Science News Letter 37:2:184. March 23, 1940.

[8] Doran, William L. Soil as rooting medium for cuttings. Amer. Nurseryman 72:5:7-8. 1940. (Contribution No. 374.)

tion vegetatively was attempted. There was little or no success with cuttings, treated or not, which were taken in spring and summer; but cuttings taken in late winter from the lower, not the upper, branches of a tree about thirty years old rooted 70 percent in sand-peat in three months after treatment for 5 hours with indolebutyric acid 200 mg. per liter. Similar cuttings failed to root without treatment, and treatment with more dilute solutions of indolebutyric acid for 20 hours was too long. Some of the results of this work were published recently.[9]

Solutions of root-inducing substances are more effective with cuttings of some species if used at higher than room temperatures. December cuttings of *Taxus media*, in sand, rooted 70 percent without treatment, 80 percent after treatment with indolebutyric acid (50 mg./l., 19 hr.) at an approximately constant temperature of 65° F., 100 percent (and more rapidly and with better roots) after similar treatment at an initial temperature of 86° F. for 3 hours followed by treatment with the same solution at 65° F. for 16 hours. November cuttings of *Picea pungens* var. *globosa* had their rooting improved by indolebutyric acid (25 mg./l.) applied at an initial temperature of 86° F., falling to 65° F.; but there was no improvement when it was applied at a constant temperature of 65° F.

Rooting of cuttings of several species, taken in late fall or early winter, was more improved by treatment for 16 to 24 hours with indolebutyric acid (50 or 100 mg./l.) in a sugar solution (2.5 percent) than by similar treatment with indolebutyric acid in water. Cuttings of Pfitzer juniper rooted 44 percent after treatment with indolebutyric acid in water, 100 percent after treatment with that acid in a sugar solution. Cuttings of a species of Cytisus rooted 40 percent in 16 weeks after treatment with indolebutyric acid in water, 60 percent in 7 weeks after treatment with that acid in a sugar solution. Cuttings of *Chamaecyparis obtusa* varieties *compacta* and *magnifica* responded similarly. Cuttings of *Taxus media* and *T. media* var. *Hicksii* rooted equally well, 100 percent, with either treatment, but the best roots were on cuttings treated with indolebutyric acid in a sugar solution. Cuttings of a variety of arbor-vitae and two varieties of Norway spruce did not respond to sugar, but cuttings of *Picea glauca* var. *conica* rooted 40 percent without treatment, 55 percent after treatment with indolebutyric acid in water, and 78 percent after treatment with indolebutyric acid in a sugar solution. Cuttings of Sawara cypress rooted in larger percentages after treatment with honey in solution, but there was no response on the part of cuttings of three other species.

Rooting of summer cuttings of Hinoki cypress and Pfitzer juniper was more improved by indolebutyric than by indoleacetic acid. Rooting of early July cuttings of a lilac was more improved by naphthaleneacetic acid (100 mg./l., 5 hr., gave best results) than by indolebutyric acid.

July cuttings of *Stewartia koreana* rooted less well if made of tips of shoots than if made to include all of the current year's growth. Best rooting, 100 percent, and much better than the untreated, was of cuttings treated with indolebutyric acid 50 mg./l., 20 hr.

Optimum concentrations of indolebutyric acid and lengths of time of treatment for cuttings of some other species were 25 mg./l., 20 hr., for Cornelian cherry (in July); 100 mg./l., 20 hr., for *Rhododendron minus* (in November); 50 mg./l., 20 hr., for *Picea glauca* var. *conica* (in November).

[9] Doran, William L., Holdsworth, Robert P., and Rhodes, Arnold D. Propagation of white pine by cuttings. Jour. Forestry 38:817. 1940. (Contribution No. 372.)

Rooting of September cuttings of *Daphne Cneorum* was improved by treatment with 50 mg./l., 5 hr., or 12.5 or 25 mg./l., 20 hr. November cuttings of Gardenia rooted so well untreated that the only benefit of treatment (indolebutyric acid 25 mg./l., 24 hr., gave best results) was to hasten rooting a little. November cuttings of *Berberis candidula* rooted more than 80 percent without treatment, no better with treatment. December cuttings of Pfitzer juniper rooted 50 percent without treatment, 100 percent after treatment with indolebutyric acid 50 mg./l., 20 hr.

Study of Diseases of Ornamental Herbaceous Plants Caused by Soil-Infesting Organisms, with Particular Attention to Control Measures. (W. L. Doran.) Until better and cheaper soil disinfestants are found, it is important that more be learned about how best to use the old ones. Since damping-off is important and also convenient to work with, its control was here used as a measure of effectiveness, for what is learned in this way can be useful in efforts to control other and similar diseases caused by soil-infesting fungi.

In order to learn how the efficacy of certain soil disinfestants is affected by soil reaction, pH values of soil were adjusted with sulfur or with hydrated lime before soil treatment.

Formaldehyde was equally effective in soil with a pH value of 7.0 and in acid soils with pH values of 6.0 to 5.6.

Calcium cyanamide, 1000 pounds per acre, applied to soil two weeks before seeding, gave better control of damping-off and of a root-rot of sweet pea seedlings in soils with a pH value of 7.0 or higher than it did in a more acid soil with a pH value of 5.9. Sweet peas usually grow best, if they escape root-rot, in a soil which is not very acid and it was in such soil that calcium cyanamide was more effective.

Applications of acetic acid in the form of vinegar (about 200 cc. vinegar per square foot) which gave good control of damping-off in more acid soils at pH 5.7 to 6.0, gave poorer control in soils with pH values of 7.0 or higher. More vinegar is needed for good control in less acid soils and it was observed that a given quantity of vinegar can be used with greater safety in less acid soils than in those with a lower pH value. Growth of a few species was somewhat injured by vinegar applied to the more acid soils, but the growth of seedlings of all species used was unaffected or improved by vinegar applied to soil with a relatively high pH value. Growth of sweet peas was also improved by vinegar in the more acid soils for in such soils the control of root-rot was best. In soils with more lime, such as are usually used for sweet peas, vinegar would probably not, however, be the preferred soil disinfestant.

Aqua ammonia (containing 27 percent NH_3) prevented damping-off equally well in soils with pH values of 6.9 and 7.2 and in acid soils with pH values of 5.7 and 5.3. Aqua ammonia, 8, 16, or 24 cc. per square foot, gave good results; but 24 cc. per square foot applied 7 or 10 days before seeding injured some species, and 16 cc. but not 12 cc., interfered with the germination of beets sowed immediately after soil treatment.

Soil treatments with ammonium sulfate and ammonium phosphate were without fungicidal effect in acid soil (pH 5.4 to 5.9), but ammonium sulfate had some fungicidal effect in soil recently limed. Heavy applications of ammonium sulfate which were harmless to germination in acid soil were decidedly injurious in the limed soil. This is probably due to the

effect of ammonia, the odor of which is sometimes strong when the salt is applied to limed soil.

With the object of determining the length of time that a soil-disinfesting effect persists, or how soon soils variously disinfested become badly reinfested, seeds were sowed at various intervals of time after treatment of soil in open flats in a greenhouse. Applied immediately before seeding, formaldehyde, calcium cyanamide, formic acid, salicylic acid, oxyquinoline sulfate, acetic acid, and vinegar were about equally effective although they were not equally safe; calcium cyanamide, especially, being harmful.

Formaldehyde gave good protection against damping-off for one week, fair protection for two weeks, very slight protection for three weeks, and none whatever when seeds were sowed four weeks after soil treatment. There was partial control by the other chemicals when seeds were sowed as late as four weeks after soil treatment. When they were sowed six weeks after soil treatment, the only chemical which still showed any protective effect was calcium cyanamide.

Chemical Soil Surface Treatments in Hotbeds for Controlling Damping-off of Early Forcing Vegetables. (W. L. Doran, E. F. Guba, and C. J. Gilgut.) In a continuation of the work of determining the least quantity of formaldehyde which is or may be effective and the search for more convenient ways to apply it, soil was watered, immediately after seeding, not with water alone but with dilute solutions of formaldehyde. They were so applied that each square foot of soil surface received 0.2 to 3.0 cc. formaldehyde in 1 quart of water.

There was poor or no control by 0.2 cc., but beet, cress, cucumber, and lettuce, the seeds of which germinate relatively rapidly, were well protected by as little as 0.6 cc. and nearly as well by 0.4 cc. per square foot. A little more may be needed when more slowly germinating seeds are involved, for seedlings of eggplant damped-off with 0.6 cc. But damping-off of all these species was as well controlled by 1.0 cc. per square foot as by heavier applications.

Such an application, 1 cc., leaves a considerable margin of safety, for 2 cc. per square foot did not injure the growth of seedlings of any species and injury to growth caused by 3 cc., slight to begin with, was soon outgrown. There is, however, more formaldehyde in recently treated soil during the germination of seeds than during the subsequent growth of seedlings, and it was several times observed that germination may be injured by applications which do not affect growth. Germination of the other species was not injured by 3 cc., but germination of cress was somewhat retarded by 2 cc., not by 1.6 cc., per square foot. Crucifers are especially susceptible to injury by formaldehyde and, for them, about 1.5 cc. formaldehyde per square foot, applied as above, is probably the limit of safety.

Dusting of seeds of crucifers with zinc oxide or, in some cases, with Semesan resulted in better stands of seedlings than did the application of formaldehyde to soil after seeding. Both zinc oxide and Semesan dust, as seed treatments, gave better results with crucifers than did red copper oxide.

Formaldehyde 1.9 cc. (in 0.8 quart water) per square foot gave good control of damping-off of spinach, lettuce, pepper, cucumber, beet, and tomato, but about 2.5 cc. gave better control with celery and Swiss chard. That quantity of water per square foot is not too much if soil is not too

wet to begin with; but it caused some packing and puddling of soil which was already too nearly saturated before treatment.

Carnation Blight Caused by Alternaria dianthi S. & H. (E. F. Guba, Waltham.) Seedling carnations obtained from last year's breeding work are now benched and growing in the greenhouse. As yet there is no indication that any of the seedlings are more resistant than the parents to either Alternaria blight or branch rot caused by *Fusarium dianthi* Prill. & Delacr.

Control of Greenhouse Vegetable Diseases. (E. F. Guba and C. J. Gilgut, Waltham.) Observations on resistance of the Bay State tomato to the tomato leaf-mold disease caused by *Cladosporium fulvum* Cke. were made on crops grown under commercial conditions, in a number of greenhouses. Under such conditions, this tomato showed 25 percent of the plants to be susceptible to leaf mold while the remainder are highly resistant. The Bay State tomato is highly pleasing to growers who in the past have frequently experienced complete loss of their fall–winter crop due to this disease. The yield has been found satisfactory. The one criticism of growers is that the fruit does not ripen fast enough.

The Bay State tomato is not a substitute for good greenhouse management. In two establishments it was found that nearly all of the plants had some mold on them. It was learned that the impression was prevalent among growers that the plants could be more or less neglected and still remain free of mold. If managed as carefully as the highly susceptible varieties of greenhouse tomato, the Bay State variety, grown as a fall–winter crop, is highly resistant to the leaf-mold disease and gives far more satisfactory results.

Factors Affecting Yield of Onions and Their Shrinkage in Storage. (C. J. Gilgut and W. G. Colby. Cooperative with Agronomy.) Twenty-six lots of onion sets were grown on typical Connecticut Valley onion soil and compared for yield and shrinkage in storage. All lots were obtained in the Valley, except six small lots for experimental trial which were shipped direct from a mid-west producing area.

There was less difference in performance of locally grown Japanese seed sets and those shipped in than was the case last year. Locally grown Japanese sets produced slightly higher yields than those shipped in, but there was no significant difference in the yield of globe type seed sets from different sources.

After 90 days in storage, shrinkage resulting from disease averaged 17.8 percent for locally grown Japanese sets and 28.6 percent for three lots of shipped in Japanese sets. The average shrinkage of globe type sets was 24.5 percent for those grown locally and 25.7 percent for those shipped in. However, the lots of globe type sets obtained for experimental trial averaged 49.3 percent shrinkage. The large shrinkage loss in this case can probably be accounted for by the fact that the sets were shipped in airtight paper bags—the seed sets heated in transit and mold had developed on the basal plates. The development of mold did not affect the growth of these sets in the field. The average yield was highest of any globe sets tested.

In accordance with last year's results, it was found that in the early part of the storage period bacterial soft rot predominated, while later Fusarium bottom rot was more prevalent.

In harvesting experiments onions pulled, clipped, and stored the same

day showed a shrinkage of 14.1 percent when stored in 50 pound crates, and 22.7 percent when stored in 50 pound bags.

In rotation experiments the shrinkage after 90 days in storage of onions grown after one year hay sod was 13.5 percent; of onions after a ryegrass cover crop, 22.4 percent; and of onions directly after onions, 17.3 percent. These are the first year's results on land which has produced onions continuously for more than 40 years.

Miscellaneous Tests and Experiments. (E. F. Guba and C. J. Gilgut, Waltham.)

1. *Apple Scab Control.* Wettable sulfurs used on an equivalent sulfur basis were compared for scab control, fruit russet, and leaf injury. All applications, except the pink and third cover sprays, contained 3 pounds of lead arsenate to 100 gallons of spray with or without 6 pounds of lime. Seven applications were made, beginning with the pre-pink on May 9 and ending on July 8. Delicious, McIntosh, and Greening varieties were used during the experiment. Fruit russet was found only on Delicious.

Kolofog, 6 pounds to 100 gallons, and micronized sulfur, 1.8 pounds to 100 gallons, used with 3 pounds of lead arsenate and with or without 6 pounds of lime, gave good control of scab on all three varieties of apples sprayed. Fruit russet produced by the Kolofog–lead arsenate spray was reduced from 17.9 percent to 9.6 percent when lime was added. The russet caused by the micronized sulfur–lead arsenate mixture was reduced by lime from 10.9 percent to 8.7 percent.

Magnetic sulfur, 1.8 pounds to 100 gallons, lead arsenate 3 pounds, and 1 pound of a commercial preparation of zinc sulfate gave less control of scab on McIntosh and Greenings, and slightly better control than most sprays on Delicious. Fruit russet was increased by this mixture.

The best scab control on McIntosh was obtained by Kolofog–lead arsenate–lime and by liquid lime-sulfur 2 gallons to 100 gallons in the precover sprays, and in the cover sprays magnetic sulfur 8 pounds, lead arsenate 3 pounds, manganese sulfate 2 ounces, soybean flour ½ ounce and lime 6 pounds. However, the latter treatment caused 23 percent fruit russet, a considerable increase over that produced by the wettable sulfur sprays containing lead arsenate with or without lime.

Leaf injury, as evidenced by yellow leaves, leaf drop, and the amount of foliage remaining on the trees at the time the apples were picked, was consistently more severe on those trees sprayed with the Kolofog–lead arsenate mixture. The most severe injury was on Delicious, which lost about 25 percent of the leaves, while the McIntosh and Greening trees lost about 8 percent each.

2. *Copper Dusts for Vegetables.* Eighteen brands of commercial prepared copper dusts were tested on cucumbers and muskmelons in the field. The copper content of the dusts varied from 3.15 to 8.8 percent.

The cucumbers were destroyed by mosaic very early in the season, in spite of good control of aphids, and no yield records or observations on fungus disease control could be obtained.

The melons grew well throughout the season and downy mildew did not appear until late. There was no noticeable difference in appearance of the foliage of the plots which were dusted and those which received no treatment. There was, however, a considerable difference in yield. The best yields were obtained with Copper Hydro Dust C (copper 8.8 percent, calcium arsenate 20 percent); Rohm and Haas Dust No. 4 (copper 5.16

percent, rotenone 0.75 percent, flour 5 percent; balance clay or talc); Copper Hydro Dust E (copper 8.8 percent, rotenone 0.75 percent); Lab 789 (copper zeolite to make 5 percent copper, calcium arsenate 10 percent, flour 10 percent, balance talc).

Dormancy of Gardenia Plants. (L. H. Jones.) A group of the Belmont strain of gardenias suddenly became dormant in the early autumn. The dormancy was characterized by a dark, dull green color and a cessation of growth. Passing the hand quickly through the foliage gave a sound as if the leaves were of paper. Attempts to break dormancy by extremes of temperature, high and low (55° F. to 90° F.), of both air and soil failed.

Of these dormant plants, more than half were infected with *Phomopsis gardeniae,* causing gardenia canker. The plants were to be used in experiments concerned with an investigation of soil temperature and chlorosis. It is known that the larger-flowered varieties, to which belongs the Belmont strain, react more quickly to any treatment affecting growth. These larger-flowered varieties are also more susceptible to the canker disease. In one greenhouse, in a bed of 231 plants, 71 percent were affected with trunk cankers.

For research work, other than problems concerned with disease, it is advisable to use *Gardenia veitchii.*

During the early winter of 1939, bud-drop was not prevalent locally, probably because of an above-normal amount of sunshine in the late autumn, which favored continued growth.

Changes in Root Temperature Cause Plants to Wilt. (L. H. Jones and G. E. O'Brien. Cooperative with Chemistry.) The sudden lowering of root temperature or the rapid increase of air temperature causes plants to wilt. The wilting may be followed by the death of tissue in areas along the margin and between veins. These drought spots indicate that water has been lost from these areas more rapidly than it could be absorbed by the roots. Root media of soil, sand, or water were all equally inefficient in protecting the plant from this type of injury.

Soybean plants, even in solution culture, wilted and suffered drought injury when the solution was cooled from 70° F. to 50° F. by placing the culture in a water bath at 50° F. However, it was learned that the plants can be acclimated to this low temperature if the temperature is slowly reduced during the dark hours of the night.

Stimulating Photosynthetic Activity. (L. H. Jones and B. Eames.) Negative results were obtained from tests of a proprietary eosin-like material designed to increase growth by stimulating photosynthetic activity. The tests were made with begonia and geranium plants during the winter, when sunlight is at a minimum and when results would be most marked and most advantageous. Check plants and test plants received equal amounts of water and light. The chemical in solution form was applied weekly to the test plants which, at the end of the period, showed no increase in root development, size of plant, or number of blossoms, as compared with the check plants.

The Effect of Root Media on Root Structure. (L. H. Jones and B. Eames.) There is evidence accruing to indicate that artificial soil and substitutes for soils alter the root systems of plants. Roots developed in one extreme of media, as sand, will sustain the plant when put into the

other extreme, i.e., water; but new growth must wait until a new set of roots is produced. Literature intimates that there is a difference in roots in different media, but there is no information in regard to just what the difference is. A study with the microscope may reveal certain differences of structure.

The Nature of an Oxidant in a Nutrient Solution. (L. H. Jones, C. A. Peters, and W. B. Shepardson. Cooperative with Chemistry.) When the solution of a soybean plant culture is covered by a mineral oil film, an oxidant is produced in the solution that can be quantitatively determined by the Micro-Winkler method for the determination of dissolved oxygen. The oxidant is not O_2; it is cumulative in the solution but not cumulative in the plant; it is produced by a living plant but not by a dead plant; the small amount of nitrites sometimes associated with it does not interfere with the quantitative determination.

If, in determining the oxidant by the Micro-Winkler method for oxygen, the sample is allowed to stand for a half hour after it is ready for titration, no returning end point is obtained. However, if the sample is titrated immediately, the end point is indefinite and continuing. This end point, if continued, will eventually come to the same figure as obtained after the half hour wait. The production of this oxidant by a plant is not understood and its composition is unknown. Some facts about its action under various conditions may aid in determining more exactly the nature and substance of this particular oxidant.

DEPARTMENT OF CHEMISTRY

W. S. Ritchie in Charge

Cooperative Analytical Service. (The Department.) Thirty-four samples of blueberry bushes raised in the greenhouse in sand cultures by the Pomology Department were sent to the laboratory to determine their response to various nutrient solutions. The yield of air-dry leaves was determined in all cases, and the percentages of nitrogen, crude ash, and iron in dry matter in 13 composites. The yield in several instances was so small that further investigation was not possible. Freezing-point determinations were made on ten of the nutrient solutions as a measure of concentrations.

The manganese, calcium, and phosphorus were determined in a poultry ration as well as in the calcite added to it. The manganese in the egg (shell and yolk) was also determined as part of the study to evaluate the role of this element in the life processes of the chicken. Details of this work will appear under the report of the Poultry Department.

Spray materials. Several samples of spray material were submitted for analysis, including two lots of nicotine, fish-oil soap cartridges used for the control of aphis, which tested 6.79 and 5.83 percent of nicotine respectively. The soap in both instances was fairly soluble and left but slight residue.

A sample of so-called Fruitone, which is applied as a spray to retard apple drop, was received from the Pomology Department. This was a fairly soft white powder used at the rate of 1 pound to 200 gallons, and consisted of about 54.50 percent of talc (spreader) and 39.50 percent of organic acids (as citric by titration), together with some hygroscopic moisture and a small percentage of declared naphthalene compounds.

Other service rendered included the analysis of cocoa for iron, the qualitative examination of material found to be limestone, and the determination of the strength of a commercial sample of formaldehyde.

Carotene and chlorophyll were determined in two standard samples and one local sample (spinach and alfalfa) by several methods as collaborative work on A. O. A. C. methods for these constituents in feedstuffs.

Testing Analytical Methods. (The Department.) In furtherance of the collaborative work on zinc in foodstuffs under the auspices of the A. O. A. C., samples of white dent corn (Johnson County Ensilage) and of spinach (Burpee's Victoria), together with granulated zinc for standardizing, were sent to analysts who had expressed a willingness to take part. Results by the Massachusetts method were promising, on the whole, but revealed some possible errors in technique that could be easily remedied. The suggestions for the coming year call for additional investigation to insure greater accuracy and easier operation as follows:

1. Complete solution of the zinc in hydrochloric acid.
2. Prevention or at least reduction of contamination by the glassware.
3. Use of dithizone in carbon tetrachloride when a suitable colorimeter and filters are available for a "mixed color" method.
4. Adoption of a specific color filter for the determination.

The Iron, Copper, Zinc, and Iodine Content of Fruits and Vegetables Used as Human Food. (E. B. Holland, C. P. Jones, and W. S. Ritchie.) The analyses of some 324 foodstuffs conducted during the past few years have now been completed. The analyses include proximate constituents and trace metals in fruits, vegetables, cereals, nuts, processed human and cattle feeds, and roughage.

Lignin and Its Relation to the Absorption of Minerals by Plants. (Emmett Bennett.) A thorough description of the objectives of this project has appeared in previous annual reports.

Last year it was noted that when corncob lignin was dispersed in sodium hydroxide and titrated electrometrically with a strong acid, data were obtained which, when plotted, produced a titration curve having two inflection points—one at about pH 4.5 and the other at about pH 8.0. A study was made of the conditions necessary to reproduce this curve. Such behavior is indicative of the activity of definite chemical groups. In some instances data may be obtained from titration curves which may be of assistance in determining the nature of the active groups. From the data obtained in this study "apparent dissociation" constants were calculated. These values were found to be comparable to the dissociation constants of substances containing phenolic hydroxyl and weak carboxyl groups. This relative agreement, however, is not conclusive evidence of the presence of phenolic hydroxyl and carboxyl groups in the material tested.

A study of the base exchange capacity of purified lignin indicated a low value. However, solution in alkali followed by precipitation and subsequent electrodialysis increased the exchange value many times. The enhanced value of the specially prepared lignin was reduced to the level of that of the original by drying at about 80°C. The enhancement in capacity is believed to be due chiefly to increased state of hydration made possible by previous treatment.

Precursors of Lignin. Data obtained from an investigation on Kentucky blue grass (*Poa pratensis*) and red clover (*Trifolium pratense*) showed no apparent relationship between pectic substances, hemicelluloses, and lignin. The lignin in red clover was associated with approximately an equal amount of pectic substances. On the other hand, Kentucky blue grass, containing an amount of lignin nearly equal to that of red clover, showed little more than a trace of pectic substances. The older plants contained about the same percentage of the pectic substances as the younger ones. The percentage of total hemicelluloses in Kentucky blue grass was about twice that in red clover.

It seems, therefore, that variations in the proportions of the three substances in the two species are probably due to differences in cell structure rather than to transformations; and that pectic substances are not found chiefly in the younger tissues.

A description of this work can be found in *Science* 91:95-96, 1940; and in *Plant Physiol.* 15:327-334, 1940.

Effect of Storage and Processing on Carbohydrates of Some Varieties of Edible Onions. (Emmett Bennett.) A description of this project was given in the annual reports for 1938 and 1939. The results from investigations on the storage of the Ebenezer onion indicated the following:

1. Soluble carbohydrates constituted approximately 60 percent of the dry matter of the onion.
2. Reducing sugars accumulated to the greatest extent in the coldest storage.
3. Loss of total soluble carbohydrates was negligible in the onions which remained sound in storage.
4. The chief losses in storage were due to decay and sprouting.
5. Low temperatures retarded the losses.

Boiling onions in the usual way for consumption decreased the content of non-reducing sugars about 13 percent.

Details of this work have been summarized and submitted for publication in the *Proceedings of the American Society for Horticultural Science.*

Chemical Changes in the Cooking of Vegetables. (M. E. Freeman and W. S. Ritchie.) The cells of baked potatoes are separated to a greater extent in mealy tissue than in waxy tissue. Previously it was shown that this does not seem to be caused by the lack or weakness of the pectinous cementing material between the cells. New technique has given additional evidence of the cell separation in mealy tissue. When slices of freshly baked potatoes are dried, the mealy tissue becomes very porous. In the waxy tissue, however, the cells adhere so firmly that the material shrinks to a dense vitreous mass. The difference between mealy and waxy tissue is so apparent that the texture can be easily scored. There are several important advantages in this method of scoring texture: (1) the dried slices can be kept as a permanent record of any test; (2) the permanent standards can be selected and used for direct comparison with any test; (3) standards can be easily exchanged by any laboratories that wish to compare their results on the same scoring basis.

From the foregoing observations, it would seem that a quantitative measure of the pore surface or pore volume of the dried slices might serve as a quantitative measure of texture. Preliminary experiments on this point have met with some success.

Texture is also highly correlated with dry matter (starch) or moisture content. This relationship has been confirmed by additional analyses for these constituents. It has been found that the specific gravity of the potato closely parallels the average moisture content, but that different parts of a tuber may vary considerably in moisture, specific gravity, and texture. When the moisture content of raw potatoes was substantially and uniformly increased, the specific gravities and, in many cases, the texture scores were lower than in the controls. The results, however, did not conclusively demonstrate a causal relationship between moisture content and texture. Moisture content of potatoes was successfully lowered only at higher temperatures, and these moisture losses were not uniform. Tubers lost 40 percent of their total moisture while the interior flesh lost only 1 to 3 percent.

The moisture–texture relationship has been investigated by studying the water-binding capacity of potato tissue and starch. Since none of the usual methods for the determination of bound water have been entirely satisfactory for these materials, modifications and their application to various starches and potato samples have been studied.

Progressive Decomposition of Fish Muscle. (W. S. Ritchie and P. N. Simon.) Changes in the physico-chemical nature of the proteins should mark the first stages in the progressive decomposition of fish muscle. Attempts to detect such changes have been made by extracting or peptizing fresh haddock muscle with water and with sodium chloride solutions of different concentrations and at different temperatures.

Typical peptization curves were indicated by the total nitrogen extracted. The maximum amount was obtained with 10 percent sodium chloride at 0°C for a 24-hour period. The slope of the curve varied with the time and temperature of extraction. Significant differences in the coagulable and non-coagulable protein fractions were obtained at 0° and 25°C with certain salt concentrations; but there was no significant change in the values obtained at 0°C with storage up to eleven days. There was, however, an apparent but unexplained increase in the total nitrogen of haddock muscle with storage time.

Twelve pounds of haddock muscle were stored for twenty days at 10° to 12°C and decomposition products were extracted with solvents.

An ethyl alcohol extract yielded a dark-brown gummy residue which was soluble in water but insoluble in ether and acetone. The components of this residue could not be separated or crystallized by dehydration. Separation by electrodialysis resulted in decomposition of the components at the cathode. Treatment with HCl effected only a partial crystallization.

N-butyl alcohol yielded mixtures of decomposition products that were easily decomposed by such mild treatment as vacuum distillation. Picrate derivatives were prepared, however, with some measure of success. Of the sixteen picrate preparations some were very unstable on recrystallization; all decomposed when heated in melting-point tubes. Identification of the picrate derivatives is being attempted by ultimate analysis.

The Influence of Base Exchange Capacity and of Exchangeable Ions in Massachusetts Soils on the Availabilty of Potassium. (Dale H. Sieling.) Samples of representative soils of Massachusetts have been collected and are being prepared for laboratory investigation. The various horizons of sixteen soils have been included in this collection, and from these samples

information should be gained which will lead to the selection of the soils most suitable for this investigation when the phase of work related to plant growth is started. Preliminary investigations of the various physical and chemical characteristics of these soils are being made at the present time.

The Relationship of Base Exchange Capacity, Exchangeable Hydrogen, and Soil Reaction to the Lime Requirement of Massachusetts Soils. (Dale H. Sieling.) Sixteen soils representing the most important soil types in Massachusetts have been collected for the laboratory investigation in this research. Arrangements have been made with several of the farmers involved to lay out liming tests on a small area of their farms after the laboratory information is adequate to give an indication of the amounts required for the various soil types.

The volume–weight determinations of these 16 soils as they occur in the field have been made and show that under field conditions the weight per acre–inch varies from 101.5 tons to 151.0 tons. These variations in volume weights should have a marked influence on the lime requirements of the different soils on the basis of laboratory tests made on weighed quantities of soils.

The Fixation of Arsenic in Soils and the Influence of Arsenic Compounds on the Liberation of Fixed Phosphorus in Soils. (Dale H. Sieling.) Soil samples have been collected from plots 4 and 8 of Block K in the Pomology Fertilizer Test Plots. These plots have received the residue from several years of spraying with lead arsenate. On plot 8, where there has been no application of phosphorus, a definite deficiency of phosphorus is noted. Samples were collected at various depths in the soil to find whether the arsenic had penetrated beyond the top few inches of the soil.

CONTROL SERVICE

Philip H. Smith in Charge[1]

With the retirement of Mr. H. D. Haskins in December 1939, Fertilizer Control was merged with the other Control Services. At the present time, the Fertilizer, Feed, and Seed Control Laws and the Dairy Law are all administered as one service. In additon, a large amount of work is done not only for other departments of the institution, but also for other State institutions and for citizens as well.

Fertilizer Inspection. Records for the year show that 121 firms have registered 492 brands of mixed fertilizers and fertilizing materials and 52 brands of agricultural lime and gypsum. The gross receipts from the registration of the fertilizer and lime products and from fertilizer tonnage fees were $14,491.28.

For inspection purposes 1,815 samples, representing 534 brands and 13,254 tons of materials, were drawn from stock found in the possession of 425 agents or owners located in 157 towns and cities of the State.

[1] The Control Service Staff consists of: Philip H. Smith in charge; F. A. McLaughlin, Seed Analyst and Microscopist; J. W. Kuzmeski, H. R. DeRose, A. F. Spelman, L. V. Crowley, F. J. Farren, Chemists; Jessie L. Anderson, Seed Analyst; James T. Howard, Sampling Agent and Inspector; G. E. Taylor, Laboratory Assistant.

The following summary shows the character of these substances, as well as statistics with reference to their inspection:—

	Brands Registered	Brands Collected	Samples Drawn
Mixed fertilizers	317	328	1,029
Ground bone, tankage and fish	39	35	133
Nitrogen products, mineral and organic	47	40	214
Phosphoric acid products	26	25	121
Potash products	21	21	84
Dried pulverized natural manures	26	26	95
Nitrate of potash	7	6	18
Peat products	2	2	3
Wood and cotton hull ashes	5	5	9
Miscellaneous	2	2	8
Lime products	52	44	103
Totals	544	534	1,817

Feed Inspection. During the fiscal year 1,628 samples of feeding stuffs were officially collected and examined in the control laboratories. The gross receipts from the registration of feeding stuffs in 1940 were $25,300, derived from 1,265 brands at $20 each.

Dairy Law. During the year ending December 1, 1940, 7,838 pieces of Babcock glassware were tested; 93 certificates of proficiency were awarded; and 235 creameries, milk depots, and milk inspectors' laboratories were visited in order to check methods and to pass upon equipment in use. As a result of this inspection, three machines were condemned. These will be either replaced or put into condition to operate satisfactorily.

Miscellaneous Analytical Work. (Fertilizer and Feed Laboratory). In addition to the work required by the several regulatory activities under its administration, Control Service is interested in collaborative work with other departments of the Experiment Station and College; the examination of samples of feeds, fertilizers, and other agricultural products submitted by citizens of the State; the testing of feeds and fertilizer bought by State institutions; and investigational work on new methods of chemical analysis for the Association of Official Agricultural Chemists.

In order to indicate the wide scope of the work, the following statistical data are appended:—

Apple spray residue	7
Feeds, from farmers and dealers	63
Feeds, from State institutions	959
Feeds and forage crops, Experiment Station	348
Fertilizer mixtures	40
Ice Cream	113
Insecticides and fungicides	7
Limestone (AAA distribution)	26
Milk	351
Peat	11
Poultry feces (In connection with experiments)	76
Poultry grits	3
Poultry manures (Fertilizer)	3

Referee and check samples, fertilizer and feed	17
Tannin in cocoa	24
Specimens for mineral poison	5
Sewage deposits	4
Superphosphate (AAA administration)	19
Water	3
Miscellaneous	10

Seed Control. From December 1, 1939, to December 1, 1940, the Seed Laboratory received and worked 2900 samples of seed, of which 1055 were collected by the State Commissioner of Agriculture and 1845 were sent in by seedsmen, farmers, and various State institutions. In addition, 194 samples of flower seeds, for field tests only, were also received from the State Commissioner of Agriculture.

Classification of these samples, with the total number of laboratory tests involved, is shown in the following summary. It will be noted that 4100 tests were required for the 2900 samples; 870 for purity, and 3230 for germination.

Number of Samples		Number of Tests	
		Purity	Germination
721	Field Crops for Purity and Germination	721	721
5	Field Crops for Purity Only	5	.....
181	Field Crops for Germination Only	.....	181
103	Lawn and Other Types of Mixtures for Purity, Germinations involving 440 ingredients	103	440
41	Lawn Mixtures for Purity Only	41	.....
13	Lawn Mixtures for Germination Only, Germinations involving 52 ingredients	.....	52
1542	Vegetables for Germination Only	.....	1542
43	Herbs for Germination Only	.....	43
98	Flower Seeds for Germination Only	.....	98
147	Tobacco Seeds for Germination Only	.....	147
6	Tree Seeds for Germination Only	.....	6
2900	Totals	870	3230

Field tests to determine trueness to type were conducted in cooperation with the Departments of Olericulture, Floriculture, and Agronomy, which tested 253 samples of vegetable seeds, 194 samples of flower seeds, and 123 samples of corn, respectively.

The Seed Laboratory cleaned 2 lots of onion seed and 100 lots of tobacco seed for Connecticut Valley farmers. The gross weight of the tobacco seed was 156.7 pounds and the net weight for the cleaned seed was 121.5 pounds.

Corn, oats, barley, and wheat, (187 samples), purchased by various State institutions, were examined for conformity to grade purchased; and 84 samples of ground cattle and poultry feed, collected by inspectors or sent in by dealers and farmers, were examined microscopically.

THE CRANBERRY STATION

East Wareham, Massachusetts

H. J. Franklin in Charge

Injurious and Beneficial Insects Affecting the Cranberry. (H. J. Franklin.)

Hill Fireworm (Tlascala finitella (Walker)). In the last annual report of the cranberry station,[1] some pupae of this species were mentioned as remaining on November 27, 1939. These pupae lived through the winter and spring and their moths emerged June 9 to 15. These moths were all somewhat larger than those that had come out in late August and early September, their wing expanse being about fifteen-sixteenths of an inch and their length to their wing tips about seven-sixteenths of an inch.

A severe infestation by this insect occurred this season on a bog at Onset, Mass., over an acre replanted in May 1940 being badly damaged.

Cranberry Weevil (Anthonomus musculus). The following treatments were tried on this pest:

1. Six pounds of tartar emetic and 24 pounds of brown sugar in 100 gallons of water, 400 gallons to an acre, applied on June 8, 1940, reduced the count in a week from 52 to 20 weevils to 50 sweeps of the net, and only a very light infestation of the new brood was found on the treated area on August 6.

2. Basic copper arsenate, a new product of the Sherwin-Williams Co., applied on August 6 at the rate of 6 pounds in 100 gallons of water, 400 gallons to an acre, killed 94 percent of the weevils of an infestation of 134 to 50 sweeps of the net.

3. A broadcast of 200 pounds to an acre of Go West weevil bait on June 6 reduced an infestation of 210 weevils to 50 sweeps of the net 68 percent in 8 days.

4. Barium fluosilicate, applied on August 6 at the rate of 6 pounds in 100 gallons of water, 400 gallons to an acre, killed 90 percent of the weevils of an infestation of 86 to 50 sweeps of the net.

5. Cryolite used as a spray, 6 pounds in 100 gallons of water, 400 gallons to an acre, or as a dust, 30 pounds to an acre, was very effective in many cases but only moderately so in others. This variation in results may have been due to different timing of the treatments relative to the main feeding periods of the weevils.

In the experience with this insect so far, the Bordeaux mixture–calcium arsenate–soap spray, basic copper arsenate spray, cryolite spray and dust, and very high grade (Kenia) pyrethrum dust have been the more effective insecticide treatments.

Cranberry Aphid (Myzus scammelli Mason). This species, lately described as new,[2] has been under the writer's observation for thirty years. It is found only on bogs which are not reflowed during the growing season. It is sometimes quite abundant and would be an important pest were it not well checked by its natural enemies, the larvae and adults of the following lady beetles, named in the order of their importance in this, being very effective[2]; *Coccinella transversoguttata* F., *Coccinella 9-notata* Herbst., *Hippodamia parenthesis* Say, *Coccinella 11-punctata* L.

[1]Mass. Agr. Expt. Sta. Bul. 369:34. 1940.

[2]Mason, Preston W. A revision of the North American aphids of the genus Myzus. U. S. Dept. Agr. Misc. Pub. 371, pp. 2, 5, 18. 1940.

Cranberry Root Grub (*Amphicoma vulpina*). One of the cranberry growers made an interesting attempt to kill the grubs of this pest by flooding an infested bog on May 10 with a solution of sodium cyanide, 6 ounces to 100 gallons of water. The cyanide was added by a measured feed to the water of the flood at the flooding gate in the form of a strong stock solution. This poisoned flood remained on the bog 27 hours, and analyses made from time to time showed that the poison was disseminated over the bog in quite even strength and that its strength was well maintained. This treatment did not harm the cranberry vines noticeably, but it killed hardly 70 percent of the grubs, being very definitely less effective than the usual cyanide application with pumping rigs and hose. It was also, of course, much more costly.

On May 15, paradichlorobenzene was used to kill these grubs. It was applied with a fertilizer distributor, at the rate of 600, 800, and 1200 pounds to the acre on different plots, and then covered with nearly an inch of sand. It was necessary to use the chemical in crystals of the particle size of very coarse salt, for larger crystals did not feed through a distributor well and fine ones did not sift down through the cranberry vines so as to cover the bog floor beneath them evenly. The chemical slowly volatilizes into a non-inflammable gas five times as heavy as air and permeates the surface soil thoroughly. The gas acts slowly and takes several weeks to kill insects. In these experiments, the kill was finally practically complete with 1200 pounds to the acre, and 800 pounds killed half the grubs. Further experience with this treatment is needed, but it may be useful on bogs that drain into public water supplies or into waters with fish, where cyanide cannot be used safely. It is much costlier than the cyanide treatment, the price of paradichlorobenzene being about 12 cents a pound.

Paradichlorobenzene was also applied to a large plot on August 10, at the rate of 1200 pounds to an acre, and the resulting kill in this case, as determined on October 7, was very unsatisfactory.

Gypsy Moth (*Porthetria dispar*). Cryolite used as a spray, 6 pounds in 100 gallons of water, 400 gallons to an acre, and as a dust, 30 pounds to an acre, was effective in killing the caterpillars of the gypsy moth and of the false armyworm in somewhat later stages of growth than is lead arsenate, but it failed to check maturing gypsy moth caterpillars. Derris powder (4 percent rotenone), 15 pounds in 100 gallons of water with 2 pounds of soap, 400 gallons to an acre, killed maturing gypsy moth caterpillars fully as well as pyrethrum dusts and at considerably less cost. Basic copper arsenate, 6 pounds in 100 gallons of water, 250 gallons to an acre, was more effective in killing maturing gypsy moth caterpillars than any other strictly stomach poison ever tried in our cranberry investigations. Though it was somewhat less effective than pyrethrum and derris, it probably will often be useful against the largely grown caterpillars where the crop prospect is poor and the main object is to save the vines.

Grape Anomala (*Anomala errans*). Grubs of this species were found early in May throughout a bog of 17 acres in the Wenham section of Carver.

Black-headed Fireworm (*Rhopobota*). Basic copper arsenate, 6 pounds in 100 gallons of water, 250 gallons to an acre, failed entirely as a treatment

[3] Named by Dr. Richard Dow, Curator of Insects of the Boston Society of Natural History.

for this pest. A spray of cryolite, 6 pounds in 100 gallons of water, 300 gallons to an acre, was very effective against the first brood but failed to curtail the second well. Dusting with cryolite proved to be unreliable for either brood.

Blunt-nosed Leafhopper (*Ophiola*). Cryolite, 6 pounds in 100 gallons of water, 400 gallons to an acre, failed entirely as a control for this pest.

Cranberry White Grub (*Phyllophaga*). Considerable cranberry infestations by this species are found only in bogs that are flooded during the winter and have not been reflowed in late May or June for several years. Apparently such late reflooding interferes with the egg-laying of the beetles enough to serve as a control. Individual grubs of this insect are three times as destructive as those of the cranberry root grub (*Amphicoma*), and they travel around in the soil much more. The cyanide and the flooding treatments used against the root grub are also effective against the white grub. This white grub is always present more or less in the soil of the uplands around the bogs and it attacks the roots of cultivated blueberry plants extensively.

Cranberry Fruit Worm (*Mineola vaccinii*). Cryolite, 5 pounds in 100 gallons of water, 400 gallons to an acre, was fully effective against the fruit worm. Dusting with a mixture of 60 pounds of talc and 40 pounds of cryolite, at the rate of 60 pounds to an acre, was also effective. Spraying for this insect, in spite of its greater cost, is fully as advisable as dusting, for dusting seems to do more mechanical injury to the crop after the berries have begun to grow than does spraying.

Colaspis Rootworm (*Colaspis brunnea* var. *costipennis*). The infestation of this species described in last year's report[4] was kept under observation. The description of the full-grown grubs on June 12 was as follows: Length, about a quarter of an inch. Head pale yellow, the antennae not nearly reaching the tips of the mandibles. Body nearly white, without markings; the back and sides scattered over with simple pale hairs noticeable under a lens. Abdomen not noticeably darkened by its contents; the venter covered with a brush of brown hairs, those at the sides in clusters and larger than those across the middle, the latter arranged in transverse lines; the tip with a considerable prominence, ridged vertically at the end, extending caudad on each side of the anal opening. All the tarsal claws single, simple, slender, and sharply pointed.

This grub is much like that of the cranberry rootworm (*Rhabdopterus*), but its head is somewhat narrower relative to the width of the body than the head of that species.

The grubs all pupated about June 14, the winter water having been removed from the infested area early. The description of the pupa follows: Length about three-sixteenths of an inch. Color waxy white. Rather long, light brown hairs scattered freely over the upper surface of the head, thorax, and abdomen, many of them borne on conical pustules. Under surface of the body without hairs. Tips of the sheaths of the middle and hind legs each with a noticeable spine. Tip of abdomen truncate, with a strong, brown, somewhat curved spine on each side extending caudad; somewhat in front of these spines, a smaller straight spine extending squarely laterad on each side, and in front of this another spine extending caudolaterad.

[4] Mass. Agr. Expt. Sta. Bul. 369:33. 1940.

These pupae waggle the abdomen very freely when disturbed. They are very much like those of the cranberry rootworm (*Rhabdopterus*) in habits, size, appearance, and structure and in the distribution and character of all the hairs and spines described above.

All the *Colaspis* beetles emerged from the pupal condition between the twentieth and twenty-sixth of June.

For comparison with the description of the *Colaspis* grub given above, a description of the full-grown grub of the cranberry rootworm (*Rhabdopterus*) is given here: Length, a little over a quarter of an inch. Head light brown, the antennae not nearly reaching the tips of the mandibles. Body whitish without markings; the back and sides scattered over with simple brown hairs noticeable under a lens. Abdomen not noticeably darkened by its contents; the venter covered with a brush of brown hairs, those at the sides in clusters and larger than those across the middle, the latter arranged in transverse lines; the tip with a rounded light brown plate on each side of the anal opening. All the tarsal claws single, simple, slender, and sharply pointed.

Cryolite has come to stay as a cranberry insecticide. About 17,000 pounds of it were used on Massachusetts bogs during the season with generally satisfactory results. It takes four or five days to effect its kill, but it stops worm feeding on foliage very soon. It will be useful mainly against the fruit worm and as a substitute for lead arsenate where that has been used heretofore late in May. The weevil and the black-headed fireworm should soon cease to be troublesome where it is used fairly regularly against the gypsy moth and false armyworm. It doesn't seem to control spanworms as well as arsenate of lead.

Anhydro Hexitol–Cocoanut Oil Fatty Acid Esters. Aqueous dispersions of esters of anhydro hexitols and cocoanut oil fatty acids were tried against the cranberry spittle insect, the black-headed fireworm, and the blunt-nosed leafhopper. They failed to control any of these insects to any noticeable extent even when they were used in such strength that they completely destroyed the cranberry inflorescence.

Prevalence of Cranberry Pests. The relative general abundance of cranberry pests in Massachusetts in the 1940 season, as judged by general observations and by the opinions of cranberry growers, was as follows:

1. Gypsy moth in Plymouth County about as abundant as in 1939; quite destructive on the outer Cape, but less so than in 1939.
2. Blunt-nosed leafhopper about the same as in 1939.
3. Cranberry fruit worm greatly more abundant than in 1939, more destructive than for many years.
4. Black-headed fireworm about as usual.
5. Firebeetle (*Cryptocephalus*) very much less prevalent than in the last few seasons, only an occasional specimen being found anywhere.
6. Spanworms about the same as in 1939.
7. False armyworm much more generally prevalent than for many years. Blossom worm less abundant than usual. Other cutworms scarce.
8. Cranberry girdler (*Crambus*) and cranberry weevil about as in 1939.
9. Cranberry spittle insect (*Clastoptera*) and tipworm (*Dasyneura*) noticeably more prevalent than in 1939.
10. Spotted fireworm (*Cacoecia*) scattered, but more abundant than usual.

Control of Cranberry Bog Weeds. (Chester E. Cross.)

Kerosene. The water-white kerosenes of five different refining companies were again tested for their vine-burning and weed-killing properties, with results similar to those of 1939: the Atlantic, Colonial and Gulf kerosenes were less harmful to cranberry vines than the others tried; Shell kerosene did more burning than the Shell product of last year. In order of increasing toxicity to vines they stood this year as follows: Atlantic, Gulf, Colonial, Shell, and Cities Service.

The various kerosenes were all about alike as killers of grasses, sedges, and rushes. Colonial and Shell were the most effective on loosestrife.

Studies were made of relative vine burn by kerosene under varying conditions of humidity, sky, time of day, and wind. High relative humidities correlated with severe vine injury; kerosene applied from 11 a. m. to 4 p. m. burned the vines, while applications made the same day from 5 to 9.30 p. m. did no harm. Air currents are intimately associated in this with the prevailing humidity; if the latter is high, winds make the vine burn excessive; if low, they hasten the evaporation of the oil, and the vines are not hurt. Kerosene always reduces the crop when applied after the blossom buds are fully developed.

Applied in small quantities to the bases of the plants, kerosene kills bayberry and sweet gale bushes as it does hoary alders. A heavy spray to the tops of these plants is equally effective.

Ferric Sulfate. The injury to cranberry vines, reported by many growers, can be avoided by spreading this chemical evenly and brushing it off from the vines after it is applied. The margin in tolerance between weeds and cranberry vines is rather narrow, and locally increased doses harm the vines. Moisture on the vines at the time of treatment caused much injury. Dry weather after the application makes the chemical more effective in killing weeds and reduces the hazard to the vines. Midday applications are best; late afternoon treatments, even when the vines seem dry, are apt to be harmful.

Ferric sulfate was rather widely used on bogs this year. It proved very effective on horsetail, small ferns, royal fern, hardhack, wool grass (*Scirpus cyperinus*), and spike rush or needle grass (*Eleocharis*) when a small handful was applied at the base of each plant. It works on the root system, killing it completely. The cranberry vines remain unhurt if it is used carefully. It is also effective used early in the season on asters, a broadcast of 15 to 20 pounds to the square rod being advocated. Needle grass can also probably be controlled in this way, though the permanence of its kill is uncertain.

Broadcasts of 20 pounds of ferric sulfate to the square rod killed 90 percent of the rice cut-grass ("sickle grass") even where the drainage was only five inches. As cut-grass infests poorly drained areas mostly, it is hard to control with kerosene. The bog soil should be kept as dry as possible during and after the treatment with ferric sulfate.

Ferric sulfate was effective when applied early in the growing season. Plots treated late in August and in September showed only moderate kills of the weeds, and the vines were hurt in many cases.

Ferrous Sulfate. A large number of plots treated in June and July proved that dry applications of ferrous sulfate watered at once with a sprinkling can are far more effective than those left to be dissolved by rain.

A dry broadcast, 30 pounds to the square rod, killed 98 percent of

sensitive ferns; 40 pounds killed the same percentage of feather ferns and about 50 percent of long-leaved asters. Any heavier applications caused serious vine injury.

A solution of ferrous sulfate (1 lb. $FeSO_4$ to a gallon of water), tried on wild bean in June, was successful only when 3000 or more gallons were used to the acre. Some tip injury resulted then, but the treated plots were relatively weedless in August when vine recovery was complete. Wild bean had been cut down 90 percent, asters (long-leaved) 60 percent, manna grass (*Glyceria*) and reed canary grass 75 percent, haircap moss 90 percent, and feather and sensitive ferns 70 and 90 percent respectively. Treatments in May with this solution might be as effective in killing weeds, possibly without vine injury.

Iron sulfate solutions of varying concentration and quantity were applied to sensitive and feather ferns. It was concluded that dry applications for these weeds are more feasible.

Copper Sulfate. Solutions of this chemical caused some injury when applied the first week in August. The injury was to vine tips and was like the burning noticed on plots sprayed the last week in July 1939. Growers must not use this spray too early in years with a backward growing season.

Copper sulfate solutions are still the only effective treatment for "summer grass" (*Panicum verrucosum*). They burn the grass tops and prevent seeding. It is better to use 20 pounds in 100 gallons of water, at the rate of 400 gallons to the acre, than to use a stronger solution more lightly.

Solutions of copper sulfate were very effective in burning the tops of Joe-Pye weed (*Eupatorium purpureum*). This weed is common on only a few Cape Cod bogs but is a serious pest to many Wisconsin growers.

Copper sulfate, 20 pounds in 100 gallons of water, killed wild bean foliage nearly as well as sodium arsenate spray.

Paradichlorobenzene. This chemical, applied early in May with a fertilizer spreader, 600 pounds to an acre, and covered with sand, killed white violets very nicely and seems to be the most promising treatment for them so far found. It did not harm cranberry vines.

Ammonium Sulfamate and Sulfamic Acid. Ammonium sulfamate, scattered dry 1200 pounds to an acre, and sulfamic acid, scattered dry 1600 pounds to an acre, killed all weeds and cranberry vines, much as sodium arsenite and sodium chlorate do. They failed, however, to show any useful selective action.

Ocean Water. Tests on wild bean in July showed again that ocean water will kill down the weed tops for the rest of the growing season, but it was hard to apply enough to kill the bean without injurying cranberry vines a good deal. About half as many wild bean shoots came up this year on the areas treated with ocean water in July 1939, as were present when the treatments were made.

COOPERATIVE CRANBERRY INVESTIGATIONS

Conducted by the Bureau of Plant Industry, United States Department of Agriculture, in cooperation with the Massachusetts Agricultural Experiment Station

H. F. Bergman, senior pathologist, Division of Fruit and Vegetable Crops and Diseases, in Charge

Oxygen Content of Winter Flooding Water in Relation to Injury to Cranberry Vines. (H. F. Bergman.) Continuing studies made previously, measurements of the oxygen content of the winter flooding water on several bogs were made at weekly intervals from January 22 to March 8, 1940. These bogs were flooded early in December and were under ice from the middle of December 1939 until about March 10, 1940. The oxygen content of the water on all bogs, from the time the first samples were taken until the ice melted, was less than 1 cc. per liter and in some instances was less than 0.5 cc. per liter.

There was no crop on two bogs on which the water was held until about the middle of May. On other bogs the water was withdrawn late in March or early in April and the crop varied from about normal to about one-half. From limited data available, it appears that vines which had produced a large crop are more susceptible to oxygen deficiency injury during the following winter flooding period than are vines which had produced only a small crop, probably because the former have less stored carbohydrates than the latter when placed under winter flood. Vines with an ample carbohydrate reserve are able to withstand an oxygen deficiency in the winter flooding water for a longer time than those with a small supply of stored carbohydrates. One of the bogs on which the oxygen content of the winter flooding water was determined showed no oxygen deficiency injury. This bog had a very light crop in 1939. Two other bogs which had moderately good crops (50-60 barrels per acre) in 1939 showed some oxygen deficiency injury. The injury was greater in more deeply flooded areas on these bogs, which were probably also areas of greater or more prolonged deficiency. The injury was manifest in the retardation in the development of flowering uprights and of the flowers themselves and in reduced fruit production, but there was very little leaf drop.

The fourth (State) bog showed the most severe oxygen deficiency injury on an area which had produced a relatively heavy crop (75-80 barrels per acre) in 1939. The injury caused a decided retardation in the development of new uprights and of the flowers and a marked decrease in yield, as well as much leaf drop in areas in which injury was most severe.

The reduction in yield was due mainly to the failure of flowers to set fruit, but very dry weather during the late summer also contributed by reducing the size of the berries. The number of flowers produced was normal with an average of four to five per upright in each of the main three varieties on the bog, Early Black, Howes, and McFarlin. The percentage of flowers setting fruit was as follows: Early Black, Section 5, 12.8; Early Black, Section 14, 15.5; Howes, Section 13, 10.2; McFarlin, Section 13, 12.1. A normal set in these varieties would average 30 to 35 percent.

Studies are being continued on the relation between the amount of

stored carbohydrates during late fall and early winter and the probability of injury to vines from oxygen deficiency during the winter flooding period, and also on the relation of oxygen deficiency during the winter flooding period to the setting of fruit during the following summer.

Spraying Experiments for the Control of Rosebloom. (H. F. Bergman.) The following spray mixtures were applied June 20, 1940, on duplicate plots at the rate of 250 gallons per acre: bordeaux 40-4-100 and 8-8-100 each with 2 pounds of rosin–fish oil soap; basic copper arsenate 5-100 and 6-100; and yellow cuprocide 1½-100 and 2-100.

Bordeaux 10-4-100 and basic copper arsenate 5-100 and 6-100 gave complete control. Six days after the plots had been sprayed only a few living diseased shoots were found on plots sprayed with any one of these mixtures. Bordeaux 8-8-100 was considerably less effective than the 10-4-100 or than the basic copper arsenates. Yellow cuprocide 1½-100 and 2-100 were still less effective than bordeaux 8-8-100 and gave probably not more than 50 percent control.

Spraying Experiments for Cranberry Fruit Rot Control. (H. F. Bergman.) Spray tests were run on three bogs. The plots, the number of applications, and the time and rate of application were the same as in 1939 (See Bulletin 369, p. 40). The results are given in the table.

TABLE 1. THE EFFECT OF SOME FUNGICIDES ON THE CONTROL OF ROTS ON FOUR DIFFERENT CRANBERRY BOGS IN MASSACHUSETTS IN 1940

Bog and Treatment	Number of Plots	Average Percentage of Rot		
		Oct. 1	Nov. 1	Dec. 1
State Bog S 8				
Bordeaux 10-4-100	3	0.4	2.5	6.2
Cuprocide-bentonite 3-4-100	2	0.2	2.0	5.4
Copper arsenate (basic) 4½-100	3	0.3	2.4	8.1
None (check)	5	0.5	3.3	10.3
State Bog S 14				
Bordeaux 10-4-100	3	0.3	2.1	7.5
Yellow cuprocide 1-100	3	0.3	2.9	9.4
None (check)	4	0.5	4.6	11.5
Bog No. 3				
Bordeaux 10-4-100	3	1.0	7.0	33.5
Cuprocide-bentonite 4-5-100	3	0.6	6.8	29.2
Yellow cuprocide 2-100	3	1.0	9.7	40.9
Copper arsenate (basic) 6-100	3	1.3	12.0	49.4
None (check)	5	1.4	12.0	40.0
Bog No. 9				
Bordeaux 10-4-100	3	3.1	4.7	8.9
Yellow cuprocide 1½-100	3	4.0	6.6	13.9
Copper arsenate (basic) 6-100	3	3.7	5.1	9.0
None (check)	5	6.1	10.9	27.0

The extent to which fruit rots were controlled on different bogs varied widely, apparently according to the density of vine growth. The best control was obtained on bog No. 9 on which the vines are least dense and the poorest on bog No. 3 which has the densest vines. There may be some other factor or factors involved, as somewhat better results have

been obtained on bog No. 3 in other years; although this bog has been found, through experiments extending over a period of years, to be one on which the control of rot is very difficult. Judging from results obtained this year on bog No. 3, cuprocide–bentonite 4-5-100 appeared to be slightly superior to bordeaux 10-4-100 for rot control. Cuprocide-bentonite 3-4-100 on section 8 of the State Bog gave as good control of rots as did bordeaux 10-4-100. Yellow cuprocide 1-100 on section 14 of the State Bog had little effect in reducing rot. Basic copper arsenate 4½-100 also appears to be ineffective since on section 8 of the State Bog it reduced the rot, up to December 1, very little in comparison with untreated plots. Yellow cuprocide 1½-100, as shown by the results on Bog No. 9 where fruit rots were controlled most effectively by bordeaux 10-4-100 and by basic copper arsenate 6-100, seems definitely to be less effective than bordeaux for rot control. The results obtained with yellow cuprocide 2-100 and with basic copper arsenate 6-100 are not conclusive. Basic copper arsenate on bog No. 9 gave as good control of fruit rots as did bordeaux 10-4-100. On bog No. 3 neither yellow cuprocide 2-100 nor basic copper arsenate 6-100 reduced the amount of rot, up to December 1, as compared with that in berries from nonsprayed plots and basic copper arsenate appears even to have increased it.

Blueberry Disease Investigations. (H. F. Bergman.) Severe defoliation and dying-back of twigs and small branches, and sometimes also of main branches, was observed in two blueberry plantings in each of which from six to twelve bushes were affected. *Phomopsis* was isolated from material from both plantings. This fungus heretofore, except in the case of two bushes in the State Bog planting reported last year, has not been known to cause greater injury than the killing of the tips of twigs.

DEPARTMENT OF DAIRY INDUSTRY

J. H. Frandsen in Charge

The Cacao-Red or Tannin-Like Substances in Commercial Cocoa Powders. (W. S. Mueller cooperating with Control Service—J. W. Kuzmeski and A. F. Spelman.) Since it seemed possible that the cacao-red (tannin-like substances) in cocoa might be one cause of the observed decrease in growth rate of white rats when excessive amounts of cocoa were added to milk, the first step in the investigation was to analyze commercial cocoa powders for cacao-red. Authorities do not agree on the chemical composition of cacao-red and most of the methods of analysis are rather crude and somewhat unreliable. Ulrich's method was used in this study because it is the generally accepted method. By this method the amount of cacao-red in cocoa is reported as weight of the insoluble iron compound. Sixteen samples of commercial cocoa powders have been analyzed and values for the iron precipitate ranged from 2.62 to 15.59 percent, with an average of 10.83 percent. In general, unprocessed cocoa was found to have a higher cacao-red content than the processed cocoa.

It was thought that Ulrich's method could be improved by investigating the composition of the insoluble iron compound. Accordingly, the Control Service has analyzed the insoluble iron precipitate obtained from various samples of cocoa powder. The following analysis is typical for a number of samples:

	Percent
Ash	9.6
Fe in ash	38.8
PO_4 in ash	56.1
$FePO_4$ in ash	89.0
Fe_2O_3 in ash	8.2

Further analyses are necessary before definite conclusions can be drawn. However, the results to date indicate that values obtained for cacao-red by Ulrich's method are somewhat high and that this error could be reduced by ashing the insoluble iron compound and subtracting the weight of ash from the weight of the iron precipitate.

Experiments are under way to determine whether or not there is a correlation between the amount of cacao-red in cocoa and the digestibility of the chocolate milk.

The Effect of Various Methods of Pasteurization on Chocolate Milk. (W. S. Mueller and L. D. Lipman.)) The methods of pasteurization which have been studied are the Electropure process at 162° F. and ordinary vat pasteurization at 143°F. for 30 minutes and at 160°F. for 15 minutes. Preliminary conclusions from this study are as follows:

1. The Electropure method of pasteurization gave smaller cream volumes than the vat process. When an unstabilized chocolate milk was used, sedimentation was greater in the Electropure-processed milk than in the vat-processed milk. On the other hand, when a stabilized chocolate milk was used, no marked sedimentation occurred in either process; however, the vat-pasteurized milk tended to show a very slight sediment of a few small particles, whereas the Electropure processed milk showed no sediment.

2. The method of pasteurization had no effect on the flavor except that the vat process at 160°F. for 15 minutes caused a slight cooked flavor in the finished product.

3. The Electropure process gave lower phosphatase results than the vat process except when the vat pasteurizing process was changed to 160°F. for 15 minutes. In such cases the vat process gave lower phosphatase results.

4. The vat method of pasteurization tended to cause a greater percentage reduction in bacteria count than the Electropure method. This difference was more noticeable when stabilized chocolate milks were processed, and especially when the vat process was changed to 160°F. for 15 minutes.

5. The Electropure process tended to produce a more viscous product, especially when the chocolate milk contained a stabilizer.

The Bacteriology of Chocolate Milk, Chocolate Syrup, and Cocoa Powders. (W. S. Mueller in cooperation with Department of Bacteriology.) For further information on this study, refer to report by Department of Bacteriology.

Improving the Flavor and Keeping Properties of Milk and Some of Its Products. (W. S. Mueller and M. J. Mack.) The antioxidative properties of the following sugars have been tested by adding them to susceptible milk: raw cane, raw cane treated with filter cell, etc., refined cane, raw beet, intermediate beet, pure granulated beet, beet molasses, refined blackstrap, corn sugar, and cane sugar with added extract of cereal flour. No

significant differences were noted between the different kinds of sugars. However, considerable differences were noted between the refined and raw sugars. The refining process seems to destroy some of the antioxidative properties of the sugar.

Cocoa shell was found to contain an antioxidative substance nearly as potent as that obtained from the cocoa powder. Dried extracts of cocoa shell proved to be an effective antioxidant when added to milk. An attempt is being made to isolate the antioxidant from cocoa powder and cocoa shell.

It was found that puffed oat flour goes into solution more readily and has slightly better stabilizing properties than ordinary oat flour. The antioxidative properties of puffed oat flour were equal to those found in ordinary oat flour when these substances were added to susceptible milk. Puffed oat flour, however, imparted a stronger flour taste to both ice cream and milk than ordinary oat flour.

The Effect of Various Antioxidants on the Behavior of Gelatin or Other Stabilizers in Ice Cream. (W. S. Mueller.) Today some ice cream manufacturers are adding antioxidants to ice cream mix in order to improve the flavor of their product. This practice has brought up a new problem, for some antioxidants also possess stabilizing properties and may cause overstabilization of the ice cream unless the amount of stabilizer ordinarily used is decreased. Several antioxidants were found to affect the action of gelatin in ice cream. Some ice cream manufacturers want a product which combines the antioxidant with the stabilizer. This brings up another problem for the amount of some antioxidants which is necessary to protect the flavor would raise the stabilizer content in ice cream above maximum amounts set by some states. Oat flour used with gelatin is an example. Oat flour has been found not to interfere with the efficiency of gelatin in ice cream. Studies are being continued to find an antioxidant that is potent enough so that only a small quantity would be used and that would also combine with the gelatin.

Cooperative Study with the American Dairy Science Association Committee on Methods for Determining the Curd Tension of Milk. (W. S. Mueller.) The major factors studied during the past year were: the stability of the coagulant (N.1 HCl + .45 percent U.S.P. 1:3000 dry pepsin) when stored away from light in a refrigerator; design and sharpness of knife; design of coagulating vessel; effect of covering the coagulating vessel during coagulation of the milk; speed of knife or vessel; and feasibility of specifying surface readings instead of continuous or secondary readings.

Results so far obtained indicate that the coagulant need not be made fresh daily, and if properly handled may retain its activity for one week. A knife of smaller total diameter but with the same lineal cutting edge is being compared with the knife furnished with the Submarine Signal and American Curd-O-Meter instruments. The former knife gives readings which are approximately 15 percent lower than those obtained by the use of the standard knife. Covering the coagulating vessel increased the surface or maximum curd tension reading but had little effect on the secondary or continuous reading. No significant differences were noted in deviations from the average curd tension when surface and continuous readings were compared.

The Use of Corn Syrup Solids in Ice Cream and Ices. (M. J. Mack and L. R. Glazier.) A new sweetener for use in frozen dairy products has recently been made available—dry corn syrup solids. This product results from the dehydration of corn syrup to a stable, white amorphous powder which looks like confectioners sugar. The approximate analysis of corn syrup solids is: dextrose 21 percent, maltose 33.2 percent, dextrines, 43.3 percent, and moisture 2.5 percent. Since this sweetener is less expensive than sucrose, the partial replacement of sucrose by corn syrup solids is desirable, provided the quality of the finished product is not lowered by the change.

Sugars have two principal functions in frozen dairy products: one to contribute sweetness, and the other to improve body and texture. Sucrose is sweeter than the corn sugars. However, certain combinations of sucrose and corn syrup solids improve the body and texture more than an equivalent weight of sucrose. The relative desirability of the ice creams made in this study was determined by consumer preference tests. The consumers did not know the identity of the samples they were judging.

The replacement of 20 percent of the sucrose of ice cream by corn syrup solids did not make a perceptible change in sweetness; but when the replacement was 25 percent, some consumers recognized a slight lowering of sweetness, although the majority did not. As the replacement of sucrose by corn syrup solids progressed above this amount, more and more of the judges noticed a loss in sweetness of ice cream. The use of corn syrup solids improved the body and texture of ice cream; this was noticed by at least 70 percent of the consumers. The final preference of the majority of the judges was for the ice creams in which 20 or 25 percent of the sucrose was replaced by corn syrup solids, rather than for those containing sucrose alone. A somewhat higher replacement of 33 1/3 percent of corn syrup solids for sucrose was preferred in ices and sherbets.

There are several other effects produced by corn syrup solids in ice cream. When this sweetener replaced 25 percent of the sucrose, the mix viscosity was increased about 10 percent and the titratable acidity was increased very slightly, but the stability of the proteins of the mix remained unchanged. The replacement had no adverse effect on the whipping ability of the ice cream mix.

The use of corn syrup solids, in combination with sucrose, improved noticeably the body and texture of ices and sherbets, as well as ice bars. The formation of a surface crust of crystallized sucrose, which is often troublesome with ices and sherbets, was prevented by the replacement of one-third of the sucrose ordinarily used in these products by corn syrup solids.

The Appearance of Melted Ice Cream. (M. J. Mack.) When ice cream is scored, using the score card approved by the American Dairy Science Association as a guide, the melting appearance of the product is considered. Ice cream should appear smooth and creamy when melted; undesirable defects listed on the score card are "curdy," "wheys off," and "does not melt."

The melting appearance of ice cream is a factor of importance, yet it has been given little attention in research. Defects in melting appearance have been attributed to a partial loss in stability of the proteins of ice cream, caused by acidity development, unusual proportions of the minerals present, or faulty homogenization. Marked defects in melting ap-

pearance are undoubtedly caused by factors which affect the stability of the proteins, but this explanation does not seem to be true when the defects are slight.

A number of factors, in addition to those already mentioned, have been found to affect the appearance of melting ice cream, such as the composition of the mix. High butter fat content, low sugar concentration, and an excessive amount of stabilizer may all contribute to the difficulty. The kind of stabilizer used is also important, since stabilizers vary in their effect on the melting characteristics of ice cream. Fast freezing and hardening are both necessary in order to secure a smooth melting appearance. Dipped ice cream has a more desirable melting appearance than packaged ice cream, which shows that the percentage of overrun is also involved.

Ice cream which has desirable melting characteristics can be secured by the use of good ingredients, properly proportioned. The homogenization temperature and pressure must be satisfactory for the composition of the ice cream, and rapid freezing and hardening are also essential.

A Study of the Efficiency and Practicability of the Paper Milk Bottle. (J. H. Frandsen and M. A. Widland.) As far as the study went, no off-flavors seemed to be due to the paper bottles.

A Comparison of the Electropure and Vat Methods of Pasteurization. (Leo D. Lipman, J. H. Frandsen, and H. G. Lindquist.) Split batches of raw milk were pasteurized in (a) the Electropure at 162° F. for 16 seconds and in (b) a spray vat at 143° for 30 minutes. Preliminary conclusions from this study are:

1. The reduction in the vitamin C content of milk was less rapid in Electropure-pasteurized milk than in raw or vat-pasteurized milks.
2. The Electropure method gave better (i.e. lower) phosphatase results than the vat method.
3. Pasteurization by both methods decreased the cream volume. While the Electropure method tended to give a greater cream volume than the vat method, the difference was so small that no definite conclusions can be drawn as to which of the two methods of pasteurization results in a lesser decrease in cream volume.
4. There was no significant difference in efficiency of bacterial reduction between the vat and Electropure methods of pasteurization.
5. Electropure-pasteurized milk became oxidized less rapidly, less frequently, and to a lesser degree than vat-pasteurized milk. A cooked flavor was found more often and was more pronounced in vat-pasteurized milk than in Electropure-pasteurized milk.

DEPARTMENT OF ECONOMICS

Alexander E. Cance in Charge

Land-Use Problems in Massachusetts in Relation to a Balanced Program of Land Utilization. (David Rozman.) The work on this project continued with the analysis of land-use factors in the light of economic and social conditions as they affect individual communities in rural areas. The program of land-use classification advanced to a point where detailed information is now available for over 300 rural towns of the Commonwealth. This includes the analysis of interrelationships between basic factors, as movement of population, tax rate, types of soil, land use and cover, road conditions, and other facilities and improvements in rural areas.

During the past year especial emphasis has been placed on the analysis of types of farming and the degree of diversification prevailing in various sections of the State. The study of these facts has been brought into prominence in connection with the accelerated defense program and the possibility of changes in the farming organization. These are expected to develop as a result of the shortage of farm labor and the changing level of prices for both farm products and the products purchased by the farm operators.

In Bristol County, where a complete analysis of the farm enterprises was carried out, a considerable amount of diversification is indicated. Out of a total number of 1,259 commercial and semi-commercial farms investigated, 647 or 51 percent had two or more farm enterprises; and of these, 205 farms, or 16 percent of the total number, had three or more different enterprises. The farms with only one enterprise numbered 612 or 49 percent of the total. The degree of diversification in commercial and semi-commercial farms compares favorably with that of farms operated on a self-sufficient or a part-time basis. The investigation and analysis carried out for the latter in the same county indicate only 33 percent of the total number of units having two or more enterprises.

It has been generally recognized that, whatever changes in farm organization are brought about as a result of the new influences, it is important to maintain a certain amount of self-sufficiency and diversification of enterprise to meet the conditions after the present acceleration of business activity is terminated.

Left: Two Sunflower Plants per Hill—Crop Almost Complete Failure.
Right: One Sunflower Plant per Hill—Strong Stalk with Large Seed Head.

The Effect of Increasing Dosages of Arsenic (As_2O_3) with a Constant Amount of Organic Matter on the Growth of Buckwheat.

D1—control; D1'—organic matter alone; D4—1500 p.p.m. of arsenic; D4'—1500 p.p.m. of arsenic with organic matter; D5—2000 p.p.m. of arsenic; D5'—2000 p.p.m. of arsenic with organic matter.

Hog Cranberry Used to Control Slope Erosion on Sandy Hills and Roadside Embankments on Cape Cod

DEPARTMENT OF ENGINEERING

C. I. Gunness in Charge

Cranberry Storage Investigation. (C. I. Gunness, H. J. Franklin, and C. R. Fellers.) Cranberries from the 1940 crop were stored in a modified atmosphere. Berries were stored in air-tight steel cabinets, the covers being made tight by a water seal. Two rooms were operated: one at 35° and the other at 45°. Two cabinets were placed in each room. In one cabinet in each room an atmosphere of 5 percent carbon dioxide and 2 percent oxygen was maintained; and in the other, 10 percent of carbon dioxide and approximately 11 percent oxygen was maintained. The excess in carbon dioxide above 5 percent was removed by passing the air through a solution of sodium hydroxide. The deficiency in oxygen was supplied by ventilation. The 10 percent concentration of dioxide was maintained by ventilation.

The results of the experiment were not satisfactory. The means provided for removing the water given off by respiration were found to be inadequate. As a consequence the berries were wet when the cabinets were opened. Additional moisture was admitted to the cabinets by ventilation because the air for ventilation was drawn from an anteroom which was warmer than the storage rooms. The conditions would not exist in an actual storage as the refrigerating coils would tend to remove excess humidity through frosting of the coils.

Berries stored at 35° in 5 percent carbon dioxide and 2 percent oxygen showed practically the same loss as berries stored in air at the same temperature. The other lots of berries stored in a modified atmosphere showed considerably greater loss than those stored in air; but all lots were so wet that the excessive losses could be ascribed to the moisture rather than to the condition of the atmosphere.

Berries stored in the modified atmosphere showed less coloring than those stored in air, which would indicate less ripening in the modified atmosphere.

Apple Storage Investigation. (C. I. Gunness in cooperation with Department of Pomology.) A small room in the cold storage plant at the State College was lined with sheet iron and made gas tight for a trial in the storage of McIntosh apples in a modified atmosphere. A 5 percent concentration of carbon dioxide is maintained in this room, the excess being removed by a sodium hydroxide scrubber. Apples were placed in storage in September and no results are available until the storage is opened in the spring.

Frost Protection on Cranberry Bogs. (C. I. Gunness.) The wind machine as a means of protecting cranberry bogs against frost was given further trials, both in the spring and fall of 1940. Only a limited number of trials could be made each season and the results indicated that with a temperature inversion of 7°, protection was given over a circular area of 300-foot radius.

Poultry House Investigation. (C. I. Gunness and W. C. Sanctuary.) An investigation of the operation of electric brooders in colony houses was carried on during the past winter. Identical brooders were used in a conventional uninsulated brooder house, an insulated house, and an uninsulated house in which soil cable was placed on the floor for drying the litter. The litter in the first house was considerably wetter than that

in the other two houses; and in the house provided with soil cable, the litter was drier than that in the insulated house. At the end of the trial the moisture in the litter in the uninsulated house was 48 percent, in the insulated house 37 percent, and in the house equipped with soil cable, 30 percent. Chick growth and feathering were practically identical in the three houses.

More electric current was used for the soil cable than was considered practical.

The work will be repeated during the coming season and an effort will be made to reduce the current consumption by rearrangement of the heating cable and reduction of the heating time.

DEPARTMENT OF ENTOMOLOGY

Charles P. Alexander in Charge

Investigation of Materials which Promise Value in Insect Control. (A. I. Bourne.)

Oil Sprays for Dormant Applications. (A. I. Bourne.) The close of the winter season was marked by much cold weather and snowfall considerably in excess of normal during March, while April was so unseasonably cold and wet that orchard and shade trees remained dormant throughout most of the month and seasonal development was very slow until May. Snowfall of 2.5 inches on April 12 and 13 and 4 inches on the 21st and 22d with accompanying low temperatures combined to hold the trees dormant but furnished very unfavorable conditions in the orchards for dormant applications of DN oils and similar sprays. It was difficult to operate spray equipment under such conditions, and the snow and low temperatures after applications of oils increased the danger of injury to sprayed trees.

The cooperative project with the Dow Chemical Company on a study of the value of DN sprays involved the use of different concentrations of dinitro-ortho-cyclo-hexylphenol (DNOCHP) powders dissolved in varying strengths of a commercial oil emulsion. Similar studies were made of dinitro-orthocresol (DNOC) and dinitro-phenol (DN-Phenol) compounds. These mixtures were tested in the college orchard for their effectiveness against overwintering eggs of European red mite and orchard plant lice. The infestation of European red mite in the experimental blocks was negligible, and the number of overwintering eggs of aphids was very much smaller than in 1939. The sprays were applied April 11 while the trees were in strictly dormant condition. Although there was a fall of 2.5 inches of snow the following day and an accompanying drop in temperature to 20° F., no injury resulted nor was any retardation in bud development noted. The DNOCHP–oil emulsion and DNOC–oil emulsion sprays gave practically perfect kill of aphid eggs. Unsprayed checks showed an average of 530 lice per 100 clusters on Baldwin and 890 per 100 clusters on McIntosh trees. On sprayed trees the number of lice was seldom greater than 1 per 100 clusters. The DN–Phenol combinations were noticeably less effective but gave good commercial control.

Solutions of ½, ¾, and 1 percent of DNOCHP in oils of 52, 87, and 108 sec. Saybolt viscosity, applied while the plants were in strictly

dormant condition, caused no injury on various types of deciduous ornamentals or on white spruce, arborvitae, Irish juniper, and red pine. These oils at 4 percent strength applied to lilac caused no injury or retardation of development and gave excellent control of oystershell scale.

Tests of commercial DN sprays and the DNOCHP–oil emulsion on estates and in orchards in Plymouth County, in cooperation with Mr. R. E. Huntley, again showed control of rosy apple aphid in direct proportion to thoroughness of coverage. Troublesome infestations of oystershell scale and pear psylla were also controlled. Aphid attack was also checked on various species of Viburnum, a group which suffers severe curling, dwarfing, and distortion of foliage from even a light attack. The sprayed shrubs were very conspicuous in midsummer because of their flat, normal foliage in contrast to unsprayed checks in the vicinity.

One significant result of the season's work in that region was the condition of one orchard in which commercial DN sprays had practically eliminated rosy aphid in 1939. No spray, dormant or otherwise, was applied there in 1940. Inspection of the orchard in midsummer showed serious injury to the foliage and distorted terminal growth, and the fruit was largely "aphis apples." Subsequent examination at time of harvest showed the fruit of all varieties in this orchard to be worthless.

Summer Sprays for Apples. (A. I. Bourne in cooperation with Departments of Pomology and Botany.) Tests were made of certain variations of the standard spray program to determine the value of recent tendencies in spray practices and to contrast the liquid lime–sulfur with wettable sulfur for scab control. Tests of the present standard program were made to serve as the basis of comparison; the standard program with the addition of a mid-blossom application of wettable sulfur, without arsenicals; and the standard program without the use of lime in the cover sprays. Throughout the season these were contrasted with a program of wettable sulfur with the addition of lime in the cover sprays and a similar schedule with lime but no sulfur in the cover sprays. Lead arsenate was used at a dosage of 3 pounds per 100 gallons in the pink and 3d cover sprays; 4 pounds in the calyx and 1st and 2d cover sprays, and 2 pounds in the 4th cover spray. In the standard program lime-sulfur was used at the rate of 1½ gallons per 100. The wettable sulfur was applied at the rate of 7 pounds per 100 gallons. The pathologist found scab appearing on the check trees on May 22. It increased to the point where most of the leaves and much of the fruit were infested by late June. A light infection of scab appeared on McIntosh trees in the sprayed plots during the first half of June following the prolonged rainy period in late May. Only a slight amount of additional scab infection was observed in any of the sprayed plots during the remainder of the season.

In all plots where lime-sulfur was used, its typical injury was noted, especially following the pink and calyx applications. Foliage which appeared after those sprays, however, showed no such injury, nor was any injury noted on the foliage in the plots where only wettable sulfur was applied.

Examination of the fruit at harvest showed a considerable amount of russeting in the plots sprayed with lime-sulfur. This was particularly conspicuous in the plot where lime was omitted in the cover sprays. No russeting was noted in the plots which received wettable sulfur. The

McIntosh crop showed very little scab either in the lime-sulfur plots or where wettable sulfur was used in a complete season's program, although it was much more prevalent where sulfur was omitted and only lime was used in the cover sprays. Scab was found on 61 percent of the fruit from unsprayed trees. The record showed little or no significant difference between any of the programs followed, in the matter of relative control of insect pests.

Control of Striped Cucumber Beetle. (W. D. Whitcomb, Waltham.) Unfavorable weather conditions resulted in very poor growth of melons and cucumbers in the experimental planting at Waltham in 1940. Beetles did not appear in appreciable numbers until after July 1 and were less abundant than normally at all times. Of the 3029 beetles recorded on 70 hills each of cucumbers and melons, 82.8 percent were on the cucumbers.

In these experiments, eight applications were made between June 14 and July 18, the treatments being applied when considered necessary rather than at regular intervals.

Under these conditions, nine of the eleven materials used reduced the number of beetles on the plants 90 percent or more and three of them gave 100 percent protection on the melons.

Both rotenone dusts and calcium arsenate dusts were effective in reducing the beetle population, the most effective materials being a commercial copper–rotenone dust and a homemade calcium arsenate–fibrous talc dust. Other satisfactory dusts were a commercial stabilized rotenone dust; a commercial calcium arsenate–red copper oxide dust; copper oxychloride–pyrophillite talc 1-14; rotenone–talc (.75 percent rotenone), home mix; and calcium arsenate–pyrophillite talc 1-14. Calcium arsenate–monohydrated copper sulfate–lime 10-20-70 gave good protection against the beetles but caused slight to moderate foliage injury. A tobacco–pyrethrum dust was relatively ineffective and had very little repellent action. An experimental derris spray burned the vines so badly it was discontinued after three applications.

A direct comparison between fibrous talc and pyrophillite talc as a carrier for calcium arsenate resulted in a 5 percent advantage for the fibrous talc, but this slight advantage is not highly significant.

Control of Cabbage Maggot. (W. D. Whitcomb, Waltham.) Because of the cold, wet weather early in the season, the first eggs of the cabbage maggot were not found until May 10, the same date as in 1939, and the latest date in the ten years that records have been made.

The field infestation at Waltham was moderately heavy, averaging 68 percent; but the growing conditions for cruciferous crops were extremely favorable, and in spite of this injury about 53 percent of the untreated plants produced large or medium heads. Only 22 percent of the heads were worthless where no treatment was applied, compared to 49 percent in 1939.

Under these conditions, liquid treatments consisting of corrosive sublimate solution (1 ounce in 10 gallons of water) and calomel–gum arabic suspension (4 ounces calomel and 3¾ ounces gum arabic in 10 gallons of water) gave perfect commercial control of the maggot, and produced 70 to 80 percent large or medium-sized heads.

Because of the cold weather, an application made May 18 (8 days

after the first eggs were found) was slightly more effective than a treatment applied May 11 when the first eggs were found.

Calomel–talc dust (4 percent calomel) applied at the same time as the liquid treatments was very effective and produced 80 to 90 percent large and medium heads, being much more satisfactory than in previous seasons.

Root treatments at transplanting were less effective than in 1939 providing 70 to 90 percent control and producing 60 to 80 percent large and medium heads. Pure calomel dusted on the roots gave perfect commercial control of the maggots but produced 36 percent small heads, the greatest number of any treatment, indicating some plant injury.

A direct comparison between fibrous talc and pyrophyllite talc as a carrier for 25 percent and 50 percent calomel used as root treatments favored the pyrophyllite by 10 percent, both in maggot control and in the production of large and medium-sized heads.

Control of Squash Vine Borer. (W. D. Whitcomb, Waltham.) Although the emergence of the squash vine borer moths was 10 days later than normal, the field infestation of 7.45 borers per vine in the experimental field of Blue Hubbard squash at Waltham was the heaviest that has occurred in the last five years.

Experimental control treatments using three dusts and three sprays were applied July 10, 18, 24 and 31. The dusts were applied with a hand duster. For applying the sprays, a hand wheelbarrow sprayer at about 100 pounds pressure was used for the first treatment and a power sprayer at 250 pounds pressure for the other applications.

In spite of the heavy infestation, rotenone-talc dust, a spray of nicotine sulfate 1-500 plus oil emulsion 1 per cent, nicotine sulfate spray 1-250, and copper–rotenone dust all reduced the number of borers per vine 79 percent or more. The differences between these treatments were insignificant, but the greatest protection was obtained from the rotenone–talc dust (.75 percent rotenone) and the spray of nicotine sulfate 1-500 plus oil emulsion 1 percent, with 83.22 and 82.96 percent reduction respectively. A commercial calcium arsenate–copper oxide dust and a commercial rotenone extract spray were not effective.

Yields in the experimental planting were very low owing to unfavorable growing conditions and to a late infection of bacterial wilt. Under these conditions the best yields were obtained where a commercial copper–rotenone dust and a commercial calcium arsenate dust were applied, and it was apparent that the yield was improved more by the fungicidal action of the copper than by maximum control of the squash vine borer.

Control of Onion Thrips. (A. I. Bourne.) Unusually cold, wet weather in April and throughout most of May delayed both planting and germination of onions. In the experimental plots the plants were very late in appearing and made very slow growth until well into July. The abnormally cold, cloudy weather in late June and early July also delayed the appearance of thrips and retarded their development. Many fields of set onions were practically free from thrips up to mid-July when the sets were pulled. The abrupt appearance of hot weather in late July provided conditions more favorable for both the growth of the seed onions and the increase of thrips. In the 10-day period from July 21 to 31, the daily temperature reached 83° F. or higher, and during the 5-day period from

July 26 to 30 the temperature was 90° to 94°. Relatively high humidity accompanied this period of high temperature. Blast appeared in the experimental plots in early August and caused the premature death of the plants. Plants never reached normal height and but few of them bottomed out. Thrips, on the other hand, increased rapidly during late July and early August, scarred the leaves badly, and hastened the effect of blast on the plants.

Field tests were made of a fixed nicotine and SS3 spreader, nicotine sulfate and soap, dual-fixed nicotine and Nufilm spreader, derris (4 percent rotenone) and Ultrawet, derris and Nufilm spreader, and flaked naphthalene which was applied to the soil along the rows.

The fixed-nicotine spray gave good initial control and showed marked residual effect. Derris with Nufilm spreader gave excellent kill and reinfestation was slow. The results were better than when derris was used with Ultrawet as a spreader. Dual-fixed nicotine was not effective. Naphthalene flakes gave too uneven results to be dependable. The nicotine sulfate and soap again proved the most effective of any combination in its initial action, but its residual effects were not so pronounced as those of derris. The early death of the plants, due to blast, before onions were formed made any records on relative yield impossible.

The Spray Residue Problem. (A. I. Bourne.) Effective August 10, the federal spray residue tolerance for apples and pears shipped within the jurisdiction of the Federal Food, Drug, and Cosmetic Act were raised. The tolerance on arsenic as As_2O_3 was raised from .01 to .025 grains per pound of fruit, and that on lead as PbO from .025 to .05 grains per pound. This ruling does not apply to fluoride compounds, on which the tolerance of .02 grains per pound is still in force. Neither does the present ruling extend to other food commodities than apples and pears.

The newly defined limits of tolerance are based on extensive studies by the Public Health Service and upon the recommendations of that body. This action brings a great measure of relief to many growers who have been confronted with increasing demands for more extensive spray programs to cope with increasing abundance of major pests such as apple maggot and codling moth, in the face of more and more stringent enforcement of regulations on tolerance.

Through the cooperation of the Chemistry Department, analyses of samples of McIntosh from the experimental orchards showed both lead and arsenic residues to be well below the present requirements. Samples from plots receiving the standard schedule of lead arsenate and lime-sulfur in pre-blossom and calyx applications and lead arsenate and wettable sulfur in the cover sprays showed the presence of .006 grains of As_2O_3 and .011 grains of PbO per pound of fruit. Fruit from plots receiving lead arsenate and wettable sulfur throughout the season showed .004 grains of As_2O_3 and .011 grains of PbO per pound. Lead arsenate at dosages of 4 pounds (2d cover), 3 pounds (3d cover), and 2 pounds (4th cover) per 100 gallons was applied on June 28, July 9, and July 22, respectively. The fruit was harvested September 27 and 28. During this period there was very slight rainfall, especially in August and September when the combined precipitation for the two months was less than half the normal. Even under these conditions the margin of safety was such that no washing or wiping of fruit was necessary to meet the present tolerances.

Studies of the value of fixed nicotine in late-season applications for codling moth control, as a supplement to the present spray schedule, were continued in the same commercial orchard as in 1939. Codling moth was reduced to such low proportions in 1939 that banding was discontinued in 1940. Two applications of fixed nicotine were made in addition to the regular schedule: the first in late July in substitution for the regular 4th cover spray, and the second in mid-August.

Based on the examination of McIntosh at harvest, codling moth damage was reduced to 1.09 percent on trees in the center of the orchard, and to 3 percent on border trees exposed to migration from nearby orchards. Similar records of Northern Spy showed 2.6 percent injury on trees in the center of the block and 4.7 percent on marginal trees. The damage on Rhode Island Greening was reduced to 1.4 percent. The control secured on Northern Spy was of particular interest. In 1936 codling moth injury to fruit in that block was estimated at 75 to 80 percent of the crop and was the principal reason for undertaking the test in that orchard. This was the first opportunity of checking the value of the control program on that variety, since Northern Spy is a biennial bearer and the crop of 1938 was strewn about promiscuously by the hurricane of that year.

Apple Maggot Control. (A. I. Bourne and W. D. Whitcomb.) Inspection of fruit at harvest and reports from growers indicate that very generally over the State this pest was somewhat more abundant than in 1939 and appears to be building up an infestation to serious proportions. Several factors have produced conditions favorable for such increase. In 1937, as a result of low prices, many growers failed to harvest much of the early-maturing fruit and neglected to dispose of dropped apples promptly. In the following year the hurricane disrupted normal harvesting of the fruit and much of it was left in the orchards. In 1939, as a result of the diversion features of the Surplus Commodity Program, much fruit was left under the trees. This combination of circumstances supplied conditions very favorable for apple maggot development and explains in great measure why this pest is proving so troublesome in many of the better-cared-for orchards of the State.

Emergence of apple maggot flies in cages at Waltham was the smallest that has been recorded for several years. In these cages the time of emergence was 4 or 5 days earlier than in 1939. The record is as follows:

Percent Emerged	In Sun—Light Soil	
	Cultivated	Sod
First fly	June 25	June 30
25%	July 3	July 6
50%	July 9	July 9
75%	July 15	July 15
100%	July 25	July 26
Total	126	121
% emerged	25.4	24.2

Insecticides for the Control of European Corn Borer. (A. I. Bourne and W. D. Whitcomb.) The cold, wet weather which characterized most of the spring seriously interrupted the seasonal program of many growers, delayed planting, and retarded growth of the crops. In many cases corn was planted later than usual and made very slow growth after germination. Early June was comparatively warm and stimulated the

development of both the corn and the European corn borer. In Amherst and vicinity moths began to appear during the first week of June and by the 14th larvae appeared, approximately a week later than in 1939. The first sprays were applied on June 17.

Field tests of different insecticides for corn borer control were made in cooperation with the same growers as in the previous years. The variety used was Golden Early Market, the same as in 1939, and the plantings were made on approximately the same date. The late season, however, delayed growth so that the plants were much smaller than usual at the time the first spray was applied, and a schedule of 5 applications at 5-day intervals was followed. The month of June closed with a 10-day period of some of the coldest weather on record for that time of year, and practically the same condition prevailed in early July. The corn made very slow growth and was not ready to harvest until August, nearly two weeks later than normal. Derris spray (4 percent rotenone content), derris dust (1 percent rotenone), dual-fixed nicotine dust, dual-fixed nicotine as a spray (nicotine content equivalent to nicotine tannate), and commercial prepared rotenone sprays were used in the tests. Apparently one by-product of an otherwise unfavorable season was a comparatively light infestation of corn borer. Yield records showed corn in the check plots to be 85 percent free from borers. Derris spray gave 97.8 percent clean ears, and derris dust 96 percent; dual-fixed nicotine as a dust gave 97.6 percent clean ears and as a spray 96+ percent. Only 77 percent of the yield in the check plots, however, was of marketable grade; while in the plots treated with derris spray 89.8 percent of the crop was marketable, with derris dust 79 percent, with dual-fixed nicotine dust 82 percent, and with dual-fixed nicotine spray 81.7 percent—a very favorable comparison with unsprayed corn even in a year of light infestation. The derris spray gave a reduction of 95.5 percent in borer population in the stalks as compared with the unsprayed checks, derris dust 92.5 percent, dual-fixed nicotine dust 87.9 percent, and dual-fixed nicotine spray 75 percent.

Studies of the relative effectiveness of different strengths of derris, in the Experiment Station plots, encountered the same difficulties mentioned above—unfavorable weather conditions and very slight infestation by the borer. The results indicated that a dosage of 2 pounds of derris (4 percent rotenone content) per 100 gallons was not sufficient for dependable control, and that a dosage of 6 pounds to 100 gallons did not give sufficient difference in control over the 4-pound strength to warrant the extra cost.

In tests of Bancross 39 sweet corn at Waltham, five applications (June 17, 22, 27, July 2, 12) of powdered derris root 3 pounds and Ultrawet 8 ounces in 100 gallons of water produced a gain of 16 to 20 percent in the number of ears free from injury by the first generation of the corn borer. The ear infestation in the unsprayed plot was 22.46 percent, while that in the sprayed plot was 2.67 percent where a 2-nozzle spray rod was used and increased to 6.01 percent where an orchard spray gun was used. At a cost of $1.89 per plot for spray materials, the sprayed plots produced approximately 350 and 300 ears more than the unsprayed plot.

A similar experiment was made to control the second generation of the corn borer on late sweet corn, using Carmelcross seed sown on June 21. Three applications of derris spray were made, on August 16, 21, and 27, and records were taken on September 11 when the ears were harvested. The results showed no value for spraying, the percentage of non-salable ears due to borer being 13.99 unsprayed and 14.82 sprayed. The records

clearly show that more than three applications are necessary even if they are continued nearly to harvest, since most of the infestation in the sprayed corn was from recently hatched borers. The results were further confused by a heavy infestation of corn ear worm which did not appear to be affected in any way by the sprays.

Potato Spraying Experiments. (A. I. Bourne.) Cold, wet weather during spring and early summer, which prevented planting at the usual time, delayed the appearance of the plants and retarded growth; subnormal rainfall which persisted through August and September and an early frost on September 25-26, which killed the plants in all plots, combined to form a sequence of unfavorable weather conditions unusual even for New England.

The experimental plots were planted on May 21 but young plants did not appear until well into June. On the east half of the plot the stand was very light with many "skips" so that a considerable area had to be discarded as useless for experimental purposes. Plants in all plots were green and still making growth when killed by the frost of September 25.

During the early season the infestation of fleabeetles was comparatively light and little damage was done. The attack in late July, however, was very heavy and there was considerable damage to unprotected foliage. Leafhoppers appeared late in the season and were not very numerous. A heavy infestation of potato aphids was encountered in late July and early August. In many fields in the Valley the abundance of aphids led to the greatest build-up of several species of Coccinellid beetles which has been observed for many years. In the experimental plots incipient outbreaks were checked by the use of nicotine in the sprays applied July 31 and August 7. In the test plots, 12 applications were made between June 20, when the plants were 3 to 4 inches high, and September 4 when the flea beetles and leafhoppers disappeared. Vines were killed by frost on the night of September 25–26, and the potatoes were dug October 1 to 3.

Weekly counts of flea beetle injury showed practically no difference in degree of protection from 5-2½-50 and the standard 5-5-50 bordeaux mixture. The addition of calcium arsenate in both mixtures, however, materially reduced the amount of damage, especially in the plots receiving low-calcium bordeaux. The growing season was three to four weeks shorter than normal because of the late appearance of the plants in the spring and the early frost in September. This was reflected in the yields. Records of comparative yield in the different plots were of little significance since plants in all plots were prematurely killed by the frost.

Tests of commercial materials included applications of a commercial basic copper arsenate–wettable sulfur, a basic copper–wettable sulfur combination, and a yellow copper oxide–Cherokee clay combination at dosages of 1½ and 1 pound of the copper oxide per 100 gallons of spray. Against flea beetle feeding both the basic copper–sulfur combinations gave excellent protection, fully as good as that given by the standard bordeaux with calcium arsenate added. The yellow copper oxide sprays furnished protection equivalent to standard bordeaux without arsenical.

Records at harvest showed that plots treated with the commercial sprays yielded approximately 350 bushels per acre, which was only slightly less than the yield in the standard bordeaux plots. It is probable that greater differences would have existed if early frost had not intervened, since the plants in these plots were beginning to change color and die down while throughout the bordeaux plots the plants were still green.

Introduction of Parasites of Oriental Fruit Moth in Peach Orchards. (A. I. Bourne.) This service, requested and financed by peach growers of the State, was continued in 1940, and more than 30,000 *Macrocentrus ancylivorus* were liberated in the orchards. Through the cooperation of the Department of Entomology of the Connecticut Experiment Station, Mr. A. DeCaprio was again secured to take immediate charge of this work from June 1 to July 15. More than 80 colonies of *Macrocentrus* parasites were released in the orchards of 63 growers in 9 counties of the State. Several of the county agents assisted in the release of the parasites and enabled the work of liberation in the orchards to be done with greater dispatch than would otherwise have been possible. As a result of the efficient work of Mr. DeCaprio in the collection of breeding material in New Jersey and improved technique in the laboratory, the percentage of emergence was so very high that it was possible to supply parasites for all advance orders and furnish to the county agents enough colonies to duplicate orders. The Laboratory also supplied colonies to Dr. Christopher, extension horticulturist of Rhode Island State College, for the peach growers of that state on the same terms extended Massachusetts growers. Many growers availed themselves of the offer made this year to furnish colonies in two containers. This allowed, in separate blocks or different parts of the same orchard, distribution of parasites with the proper proportion of sexes for satisfactory colonization.

During the period when the parasites were liberated weather conditions were favorable for their activity, and little or no mortality was noted.

Naphthalene and Similar Compounds as Greenhouse Fumigants. (W. D. Whitcomb and Wm. Garland, Waltham.) A complete series of thirty experimental fumigations of potted carnations was made, using a mixture of chlornaphthalene oil 3 parts and crystal naphthalene 1 part, at the rate of ½ ounce per 1,000 cubic feet for 6 hours.

One treatment gave complete control of the common red spider (*Tetranychus telarius* L.) at a controlled constant temperature of 80° F. and constant relative humidities of 80 or 90 percent. At temperatures of 60° and 70° F., and relative humidities of 80 and 90 percent, the mortality of red spiders ranged from 80 to 90 percent; while at 50 percent relative humidity the mortality varied from 50 to 83 percent.

After two successive fumigations, complete mortality resulted at 50 percent relative humidity with a constant temperature of 80° F.; at 60 percent humidity with constant temperatures of both 70° F. and 80° F.; and at 70 percent humidity or higher at all three temperatures.

These results were obtained only when the controlled temperature and relative humidity were maintained throughout the entire period of exposure.

Control of the Common Red Spider on Greenhouse Plants. (W. D. Whitcomb, Wm. Garland, and W. E. Tomlinson, Jr., Waltham.) Life-history studies under controlled conditions indicated that female red spiders (*Tetranychus telarius* L.) on carnations developed from newly hatched larvae to adults in 16.91 days at 60° F., 10.22 days at 70° F., and 6.07 days at 80° F. The same development took approximately one day less on sweet pea and one-half day less on snapdragon than on carnation. This difference was consistent at constant temperatures of 60°, 70°, and 80° F. As observed in previous studies, the developmental period at 60° F. was about three times longer than at 80° F.

In spraying experiments on roses in greenhouse benches using 8 different commercial rotenone preparations, the addition of a neutral copper fungicide decreased the efficiency of the insecticide against the red spider about 5 percent in those materials consisting primarily of rotenone and emulsifier. However, in those preparations in which rotenone was combined with other insecticidal ingredients such as thiocyanate or light mineral oil, the additon of a neutral copper fungicide had no significant effect on the red spider mortality.

In these experiments satisfactory control was obtained after four applications at weekly intervals only with those materials which contained some insecticidal ingredient in addition to rotenone and emulsifier. According to counts made 3 to 5 days after each of four applications at weekly intervals, only those sprays which caused a mortality of 50 percent or greater prevented the spider population from increasing during the spraying period; and in some cases where the population was held in check during the spraying period, it increased so rapidly after spraying was discontinued that within one week the infestation was greater than after the first application.

Many of these commercial sprays were more effective at concentrations two to three times greater than recommended by the manufacturers.

Preliminary experiments on potted rose plants gave promising results from a mixture of tartar emetic, brown sugar and wetting agent, but it was ineffective when the brown sugar was omitted. Indications of plant injury from this material were observed.

A dinitro dust was very toxic to red spider on both rose and carnation but caused some injury to rose foliage.

Biology and Control of the Apple Leaf Curling Midge. (W. D. Whitcomb, Waltham.) The apple leaf curling midge, (*Dasyneura mali* Kieff.) was generally more abundant than in 1939 and the known infested area was increased to the west and southwest by the discovery of this insect at Ashby and Westboro, Massachusetts.

In the insectary only one midge fly emerged from 325 maggots which were collected in June, July, and August 1939 and overwintered in sand, but flies emerged in 1940 from 8 to 36 percent of the maggots which were collected in September 1939 and held over winter in the same way. The transformation to flies was 42.42 percent from the maggots collected in June; 27.6 percent from those collected in July; and 13.33 percent from those collected in August.

The orchard infestation at Westford, Massachusetts, as indicated by the percentage of terminal buds on which eggs were laid, began May 24 and reached three distinct peaks on June 4-7, July 16-19, and August 23, when eggs were found on 99 to 100 percent of the buds. After June 25 practically all new growth is on watersprouts, and on trees where watersprouts are limited the actual number of eggs is relatively small even though the percentage of buds infested is high. After August 25 only one or two growing tips suitable for ovipositon by the midge flies could be found on a tree.

The emergence of maggots from rolled leaves was concentrated in two distinct peaks, that of the first generation larvae occurring on June 25 and that of the second generation larvae reaching a maximum on August 2 but being spread out over the period July 20 to August 9. Emergence in large numbers occurred only when accompanied by sufficient precipitation to thoroughly soak the leaves.

The average number of eggs per female midge fly as determined by dissection of 12 gravid adults of the second generation was 155.5±6.66, varying from 102 to 216.

Infested apple buds during the oviposition period of the first generation flies averaged 318.1±13.47 eggs per bud, varying from 198 to 404.

Applications of naphthalene flakes broadcasted under the trees reduced the number of flies of the overwintering generation emerging in cages by 83.4 percent where 1 pound of naphthalene per 100 square feet was applied, and by 80.9 percent where 2 pounds was used. The emergence of the first generation flies under similar conditions was reduced 75.42 percent by 1 pound of naphthalene and 93.31 percent by 2 pounds. The emergence from the untreated ground was 3.56 overwintering generation flies per square foot and 22.87 first generation flies per square foot. Emergence of flies from duff (dried leaves, hay, etc.) collected in the experimental orchard and caged in the insectary was none from duff treated with 2 pounds naphthalene per 100 square feet compared to 28.5 flies of overwintering generation per pound of untreated duff, and 3.69 flies of the first generation per pound of naphthalene-treated duff compared to 78.46 flies per pound of untreated duff.

Preliminary laboratory experiments with dormant sprays on apple bark containing an unknown number of overwintered midge cocoons showed no survival where dinitro sprays were applied, and a small survival where oil emulsion was applied or no treatment was given. These results were inconclusive but offer some encouragement for control by dormant sprays applied to the bark.

Control of Plum Curculio in Apples. (W. D. Whitcomb, Waltham.) The critical period of curculio activity in 1940 began on June 1, five days after the normal petal fall stage, and continued to June 7. During this period, sprays consisting of lead arsenate 4 pounds, wettable sulfur 4 pounds, and fish oil 1 pint, were applied to certain trees when the apples of each variety were approximately 4/16, 5/16 and 6/16 of an inch in diameter, as determined by measurements with calipers. The examination of 128,888 apples resulted as follows:

Variety	Size of Fruit (Inches)	Date Spray Applied	Apples Stung (Percent)
Gravenstein	4/16	June 1	20.18
	5/16	June 3	9.95
	6/16	June 5	33.28
McIntosh	4/16	June 4	7.08
	5/16	June 5	3.08
	6/16	June 7	8.35
Baldwin	4/16	June 1	4.80
	5/16	June 3	3.22
	6/16	June 5	6.14
Wealthy	4/16	June 3	5.55
	5/16	June 4	11.19
	6/16	June 5	15.13

The most effective sprays on Gravenstein, McIntosh and Baldwin were applied when the apples were approximately 5/16 of an inch in diameter and on Wealthy at the 4/16 inch size. It is also evident that the most effective spray was applied June 3 at which time the maximum temperature and greatest curculio activity of the period occurred, and that the high temperature stimulated both curculio activity and growth of apples. One timely spray during the critical period is satisfactory on McIntosh, Baldwin, and Wealthy but not on Gravenstein. On Gravenstein and Baldwin the percentage of curculio-stung apples was from 50 to 100 percent greater on the dropped apples than on the harvested apples, but on McIntosh and Wealthy the injury was 5 to 10 percent greater on the harvested fruit.

A growth of 1/16 of an inch in diameter of an apple represents an increase in surface area of 156 percent, and since this growth may occur in 24 hours, timeliness in the application of a spray is important.

Biology and Control of the Grape Plume Moth and Grape Cane Girdler. (W. D. Whitcomb and W. E. Tomlinson, Jr., Waltham.)

Grape Plume Moth. Life history studies of the grape plume moth showed that larvae hatched from 57.89 percent of the eggs which were overwintered on potted grape vines, and that all hatching occurred in the three-day period, May 14–16. The feeding period of larvae averaged 39.2 days and the pupation period 16.37 days, making a developmental period from hatching to adult of approximately eight weeks. Because of cool weather, this period was about two weeks longer than in 1939.

On heavily infested vines the number of overwintering eggs averaged 3.36 per foot of cane, or 3.18 eggs per node. Since each node ordinarily produces a shoot, this infestation is equivalent to about 3 insects for each growing shoot.

Laboratory experiments with commercial dormant spray materials gave complete mortality of eggs with lubricating oil emulsions containing 3 or 4 percent actual oil, and 90 percent mortality or higher with 1 or 2 percent actual oil in the diluted spray. Lime sulfur 1-8 gave 80 percent mortality of the eggs. Sodium dinitro cresylate was effective when diluted to 1 and 1¼ percent, but at dilutions of ½ and ¾ percent only 48 percent mortality resulted. On unsprayed canes, 63 percent of the larvae hatched.

Field experiments in home vineyards showed 80.4 percent protection where lubricating oil emulsion diluted to contain 3 percent actual oil was used, and 72.86 percent where ¾ percent sodium dinitro cresylate was used. On unsprayed vines 84.12 percent of the tips were infested. In another experiment where 58 percent of the tips on unsprayed vines were infested, treatment with ½ percent sodium dinitro cresylate gave 92 percent protection, and lime sulfur 1-8 gave 11 percent protection.

Spraying on May 1 when the buds were breaking and about one week before the larvae hatched, using lead arsenate and fish oil and lead arsenate combined with Bordeaux mixture, failed to give protection.

Grape Cane Girdler. Emergence of the grape cane girdler beetles from hibernation and their appearance in the vines occurred when the new canes were about 6 inches long. They also appeared to be stimulated by high temperatures to the same degree as the plum curculio. Mating occurs soon after the beetles leave hibernation and the first girdled canes were observed June 2.

On potted grape vines in the insectary, mated beetles averaged 3.13 oviposition punctures per female, but observations indicate a greater oviposition activity in the field. The average life of 27 individuals reared in the insectary from oviposition to adult was 54.55 days.

When burrowing in the cane, most of the larvae work toward the base of the cane rather than toward the tip, and when control by hand picking is practiced, the infested cane should be removed well below the lowest girdle.

Spraying experiments with cryolite and fish oil gave moderate protection, but during the most rapid growth of the grape canes applications at weekly intervals permitted considerable girdling between treatments.

Parasites of the European Earwig. (W. D. Whitcomb, Waltham.) In order to follow up the liberation of parasites in the Fall River–Taunton area in 1939, twenty earwig traps or hiding blocks were placed in June 1940 in the localities where parasites had been released. These were examined in July, August, September, and October, but no specimens of the earwig parasite, *Bigonichaeta setipennis*, were recovered.

The earwig population throughout the infested area was less than in 1939, especially in Fall River where the number recovered in traps was 78 percent less. In the Somerset—Taunton area, the number of earwigs captured was 26 percent less than in 1939.

Insects Concerned in the Dispersal of Dutch Elm Disease. (W. B. Becker.) Mr. W. E. Tomlinson, Jr., at the Waltham Field Station again cooperated by continuing experiments with the native elm bark beetle and the smaller European elm bark beetle. The following data were taken.

The Native Elm Bark Beetle, Hylurgopinus rufipes (Eich.). In the logs (mentioned in last year's report, page 66) from hurricane-felled trees in which eggs were laid in early June 1939 and from which adults began to emerge on July 29, 1939, emergence was observed to continue until November 3, 1939. No emergence was observed from these logs during 1940.

The Smaller European Elm Bark Beetle, Scolytus multistriatus Marsham. In the logs (mentioned in last year's report, page 66) from hurricane-felled trees in which eggs of this species were laid in early June 1939 and from which adults began to emerge on July 20, 1939, the emergence was observed to continue until September 10, 1939. Emergence was again observed from these same logs on June 5, 1940, and continued until July 22, 1940, (173 beetles emerged during 1939 whereas 883 emerged during 1940 from the same caged material).

Scouting for Elm Bark Beetles. (W. B. Becker.) In conjunction with Dr. D. O. Wolfenbarger of the Dutch elm disease laboratory at Morristown, New Jersey, scouting for *Scolytus multistriatus* was carried on in various parts of Massachusetts, especially in places where spread was most suspected. Adult beetles were found in Western Massachusetts at Richmond Furnace, Stockbridge, West Stockbridge, and Monterey, and in eastern Massachusetts at Marlborough and East Pepperell—all locations where they had not been previously found.

DEPARTMENT OF FLORICULTURE

Clark L. Thayer in Charge

Breeding Snapdragons for Varietal Improvement and Disease Resistance. (Harold E. White, Waltham.) Back-crossing and selection work is being continued with the Field Station rust-resistant strains. Greenhouse varieties of snapdragon, Lucky Strike, Afterglow, New Cincinnati, Laura, Cheviot Maid, Rose Orange, Bronze Queen, Cornwallis, and Rose Queen, were observed to be very susceptible to rust disease under field conditions. When such varieties were intercrossed, the progeny of the F_1 and F_2 generations continued to show a high degree of susceptibility to rust. However, the F_3 generation selections, particularly from a cross between Lucky Strike and Afterglow, showed definite resistance to rust disease. This is an unusual situation in that the existence of natural resistance in susceptible commercial varieties of snapdragons has not been definitely proved. The explanation offered for this type of resistance to rust is that these varieties must carry modifying genetic factors which, under conditions of intercrossing and inbreeding, permit a more complete expression of the resistance factor. The nature of this type of resistance and the extent to which it can be developed by breeding must be determined by further work.

Wilt disease (Verticillium) continues to be destructive to snapdragons in the field, though of rare occurrence under greenhouse conditions.

Effect of Plant Nutrients, Soil Reaction, and Light on Gardenias. (Harold E. White, Waltham.) Previous experiments were concerned with the effects of different nitrogenous fertilizer materials on flower production, bud drop, and iron chlorosis. This type of work has been continued with three phosphate fertilizer materials to determine whether readily available phosphoric acid, as compared to less available forms, had any specific effect on growth of gardenia plants. Additional phosphoric acid in the form of bone meal, precipitated bone, and superphosphate (16 percent), applied to soils in sufficient quantities to supply 320 pounds P_2O_5 per acre, affected flower production appreciably.

Yields on untreated plots were 20.16 flowers per plant; on plots receiving precipitated bone, 22.39; bone meal, 20.91; and superphosphate, 17.19 flowers per plant.

Bud drop was perceptibly greater on plants given organic forms of phosphoric acid. Untreated plants showed 33.88 percent bud drop; those receiving applications of precipitated bone showed 34.70 percent; bone meal, 39.40 percent; and superphosphate, 29.30 percent bud drop.

Symptoms of chlorosis due to a lack of iron were definitely more severe on plants that received superphosphate than on those given either bone meal or precipitated bone.

Cultural Requirements of Freesias. (Harold E. White, Waltham.) Freesia corms dried or precured for 28 days and planted September 14, 1939, required 155 days to reach the flowering stage, as compared to 165 days for untreated corms planted on August 17. Corms dried for 9 weeks and planted October 19 flowered in 130 days. The number of days necessary for Freesias to reach the flowering stage decreased in proportion to the lateness of planting, but the actual date of bloom was not affected by precuring treatments. Corms untreated and planted August 17 bloomed

on an average of two weeks sooner than precured corms. The plant growth and productivity of the corms were not affected by precuring treatments prior to forcing.

Freesias subjected to constant temperatures of 50°-52° F. during the rooting period after precuring were not affected favorably or unfavorably by such a treatment. Corms precured at temperatures of 45°-46° F. in a refrigerator for 1 to 4 weeks did not flower any sooner that those given a warm storage treatment.

Treatments of precuring for 1 to 11 weeks prior to forcing resulted in a loss in dry weight of the corm to the extent of 1 to 24 percent, but there was no correlation between losses in weight and forcing characteristics of the corms.

The data presented were on the variety Purity. Tests in progress with the variety Daffodil indicate that possible varietal differences may exist.

These responses of Freesias to precuring treatments were obtained with forcing temperatures of 52°-55° F.

Soilless Culture of Florists' Crops. (Harold E. White, Waltham.) Marigolds, calendulas, poppies, snapdragons, stevia, sweet peas, carnations, roses, and gardenias were grown in cinders in comparison with soil. The annual type of flowers responded quite satisfactorily to culture under soilless conditions.

Rose plants of the variety Chieftain produced an average of 16.43 flowers per plant compared to 21.37 blooms in cinders. There was 77.18 percent of flowers with 12-15 inch stems from soil-grown plants as compared to 82.45 percent from plants grown in cinders. The gain in production of 12-15 inch grades from plants in cinders was 5.27 percent.

With the variety Talisman, flower production was greater from plants in soil, 25.68 blooms per plant in comparison with 23.75 blooms per plant in cinders. However, on a grading basis Talisman plants in soil produced 79.32 percent of flowers with 12-15 inch stems as compared to 82.90 percent in cinders. The gain in production of 12-15 inch grades was in favor of cinder-grown plants to the extent of 3.58 percent.

Sweet peas sown in August in soil in a raised bench produced twice as many flowers as plants grown in cinders. Sweet pea blooms from plants in cinders were superior to those from plants grown in soil. There was a much more pronounced stimulation of vegetative growth of the sweet pea plants grown in cinders than of soil-grown plants.

Carnations responded very poorly to culture in cinders and production was inferior to that of plants in soil. However, the plants available for use in the cinders were of poor quality which may be an explanation for the poor results obtained. At least, the results would indicate that weak, inferior plants cannot be expected to respond any more satisfactorily under soilless culture methods than they would in soil.

Carnation plants growing in cinders or gravel were successfully fumigated with naphthalene compounds for the control of red spider. Fumigations were made without flooding the benches with water.

One observation in a commercial range on the use of naphthalene fumigants on carnations in gravel indicates that injury can occur. In this particular case burning of the plants occurred under soil conditions as well as on plants in gravel; apparently fumigation conditions as related to temperature, humidity, or rate of vaporization were not properly controlled. Burning of the foliage was more severe on plants grown in gravel and a

greater percentage of bud injury occurred. However, the plants in gravel made a more rapid recovery from the injury than did plants grown in soil; this was evidenced by vegetative growth response on the plants.

Gardenias did not respond favorably to culture in cinders. The chief difficulty experienced was getting the plants to take up sufficient iron to maintain normal growth. Plants which became quite chlorotic from a deficiency of iron never satisfactorily recovered even after considerable manipulation of the nutrient solutions.

Banana Stalk Fiber as a Source of Organic Matter for Soil Improvement. (Harold E. White, Waltham.) Crushed banana fiber is a waste or by-product which has been marketed by the Meloripe Fruit Company of Boston for several years. The value of this material for use as a mulch on plantings of shrubbery and market garden crops has been demonstrated previously at the Waltham Field Station.

In recent tests shredded banana fiber composted with soil for 10 to 12 months has been found satisfactory for use in the greenhouse culture of carnations and snapdragons. Banana fiber, as determined by analyses, is relatively high in carbonates of magnesium and potassium and, therefore, is alkaline in reaction. Such a material would be most satisfactory with a soil that is too acid, but if used on soil with a low lime requirement, the liming value of the banana fiber should be taken into consideration

Cultural comparisons were made between ordinary stable manure, spent mushroom manure, and the banana fiber. The banana fiber and mushroom manure were found to have a toxic effect on gardenias, causing iron chlorosis. This was probably due to the high lime content of the materials. Therefore, they should not be used on crops which have a low lime requirement, or they must be leached well with water to remove most of the soluble carbonates.

Liming Carnation Soils. (Harold E. White, Waltham.) Carnation plants of the variety New Deal Ward, grown in a soil that received no lime, produced 23.40 flowers per square foot. When lime was applied to the same type of soil at the rate of 1 ton per acre, the carnation plants produced 21.10 flowers per square foot; 1½ tons yielded 22.40 flowers; 2 tons, 20.10 flowers; and 3 tons, 21.30 flowers per square foot.

The percentages of flowers with split calyces produced by plants in the various treatments were: unlimed, 21.50 percent; 1 ton of lime, 23.20 percent; 1½ tons of lime, 24.70 percent; 2 tons of lime, 22 percent; and 3 tons of lime per acre, 25.60 percent. The average acidity test of the soil prior to liming was pH 5.6. At the termination of the experiment, soil tests on the untreated and treated plots were: No lime, pH 4.6; 1 ton of lime per acre, pH 5.3; 1½ tons, pH 5.7; 2 tons, pH 5.9; 3 tons, pH 6.4.

Plant losses from soil-borne disease organisms such as root, stem and branch rot were very low. There appeared to be no correlation between limed and unlimed soils as to the prevalence of diseased plants.

Packet Seed Studies. (Clark L. Thayer.) For a fifth season the Department of Floriculture has cooperated with the Seed Laboratory in a test to determine the quality of flower seeds sold in retail seed stores, garages, hardware stores, groceries, schools, and other retail outlets. The seeds, which were collected by a representative of the State Commissioner of Agriculture, were tested for germination and performance under field conditions.

The test included 194 lots, representing 46 genera, packeted by 32 wholesale establishments, and obtained from 53 retail outlets. Records on germination showed 146 lots, good; 30 lots, fair; 16 lots, poor; 2 lots, none. Records on performance showed 155 lots, satisfactory; 6 lots, fair; 33 lots, not satisfactory. Detailed results are reported in Control Series Bulletin 107.

DEPARTMENT OF HOME ECONOMICS NUTRITION

Helen S. Mitchell in Charge

Vitamin Requirements of Older People. (H. S. Mitchell and A. W. Wertz.) Scientific knowledge regarding the chemical nature and physiologic function of vitamins has progressed by leaps and bounds in recent years, but knowledge regarding the human requirements for the different vitamins has not kept pace with other phases of vitamin research. The vitamin requirements of young adults, college students, and children have been studied to a limited extent and more with regard to vitamins A and C than any others. Little, if anything, is known regarding the vitamin requirements of older people or the vitamins most significant in the maintenance of optimum health with advancing years. Thiamin seems to be the one most apt to be deficient.

Reports from various parts of the country, mostly in the medical journals, indicate that thiamin (vitamin B_1) administered in liberal dosage has brought about considerable improvement and in some cases complete relief from various chronic complaints and discomforts commonly associated with and accepted as inevitable accompaniments of old age. A question as to why increased need for thiamin should become evident in middle age has never been answered. Minor changes in food habits may decrease the amount of vitamin consumed; metabolic changes may increase the need; or chronic infection may destroy or use extra vitamin, thus depriving the body of its normal supply. Thus it is proposed to ask the cooperation of a limited number of people living in Amherst to help us in the study of the thiamin requirements of reasonably normal people in the seventh and eighth decades of life. Such an experiment is possible only where intelligent and scientifically minded people are willing to give their interest and support to the project.

A few years ago it would have been impossible to propose a study of this kind because so little was known concerning the function of thiamin in the body. Today we know that the body cannot store thiamin to any extent and that the excess beyond what we need is excreted in the urine unchanged. A small excess of the vitamin can do no harm. If the body has received less than its normal requirement for some time, it will temporarily store thiamin in the tissues, when given a chance, until its quota is filled. If there has been no deficiency, the excess vitamin ingested will be excreted promptly. Thus the need of the body can be studied by measuring the excess excreted in the urine after the need of the body has been satisfied.

Another reason why a study of this kind can be undertaken today better than earlier is the improvement in methods for estimating thiamin quantitatively. Until recently we were dependent upon animal feeding tests which were tedious and expensive. Today there are two or three chemical

methods available and also a yeast fermentation method. Yeast cells require thiamin in order to grow and cause sugar to ferment. The latter method is suitable for the determination of thiamin in urine and is the one we are using.

The subjects who participate in this study will be contributing both to scientific knowledge and to their own well-being, we hope. Each subject will be expected to submit to a complete physical examination by a cooperating physician. Subjects will not be expected to alter their usual food habits or disrupt their daily routine in any way. They will be asked to keep a record and furnish us with a list of foods eaten for a week or more preceding and during certain tests. Any medicines, laxatives, vitamin supplements, etc., will need to be recorded. Subjects will be asked to collect accurate 24-hour urine specimens. The plan of the experiment will be to study first the usual amount of thiamin excreted by each subject on his habitual diet without vitamin supplement of any kind. After this preliminary study, carefully graded doses of thiamin will be prescribed.

This project was started in the fall of 1940 and is being sponsored partially by Standard Brands Incorporated.

Cause and Control of Nutritional Cataract. (H. S. Mitchell, G. M. Cook and A. W. Wertz.) The experimental production of cataract in rats by feeding rations containing galactose has become a means of studying the effect of other dietary factors upon the lens. The susceptibility of this delicate tissue to injury from foreign substances as galactose in the blood stream is materially reduced by a liberal amount of protein in the ration. Whether protein or some nitrogenous substance might be protective against lenticular injury due to other causes than galactose is not known. The nature of the protein or of the protein constituents which might exert this protective action have been the subject of further study, and reports have been published as follows:

1. *The Anti-Cataractogenic Action of Certain Nitrogenous Factors.* (H. S. Mitchell, G. M. Cook, and M. D. Henderson. Arch. Ophth. **24**, 990-98, 1940.) Data presented in this paper confirm earlier reports that inadequate protein (5 percent) aggravates and that high protein (45 percent) inhibits the development of cataract in rats fed galactose. Attention was then turned to the investigation of certain nitrogenous factors. An enzymic hydrolysate of casein gave the same degree of protection as its nitrogen equivalent in commercial casein. Cystine (2 percent) and methionine (2 percent) gave only slight or irregular protection. Moreover, when the sulfhydryl amino acids were made less available by the addition of 100 mg. of iodoacetic acid or 250 mg. naphthalene to 100 g. of ration, growth was retarded but cataractous changes were not hastened. Urea at 1, 5, and 10 percent levels gave less protection than an equivalent of N fed as protein. Choline was studied by adding 1, 2, 4, and 8 percent to a 5 percent casein ration. Growth was progressively poorer the higher the level of choline fed and there was no protection against cataract.

2. *The Effect of Dry Heat Upon the Anti-Cataractogenic Quality of Certain Proteins.* (M. D. Henderson and H. S. Mitchell. J. Nutri. **21**, Feb. 1941.) The knowledge that protein exerts protective action against galactose injury in rats, raises the question as to whether the type of treatment which is known to decrease the growth value of a protein will also affect its cataract-inhibiting quality. The four proteins—casein, egg albumin, wheat gluten, and beef fibrin—were fed as purchased and after being

exposed to dry heat for 96 hours at 125° C. These proteins were then incorporated into a 25 percent galactose ration in amounts to furnish 15 percent of protein. The ration was entirely adequate in other factors.

The growth value of these proteins was damaged by heat in the decreasing order: gluten, casein, fibrin, egg albumin. The anti-cataractogenic property was reduced by heating in the decreasing order: casein, egg albumin, gluten, fibrin. Thus these two properties of protein were not damaged to the same degree by exposure to dry heat. It follows that, if the protective factor is an amino acid or group of amino acids, they are not necessarily the same as those essential for growth.

The blood-sugar values tended to be higher in the rats fed heated casein than in the plain casein groups but were not significantly different for the other proteins before and after heating. It would appear that the degree of galactemia cannot alone account for the difference in the degree of lenticular injury observed. Thus it seems that the protein factor may be protective in the presence of the high blood galactose.

3. *The Effect of the Hydrolytic Products of Casein and Deaminized Casein on the Cataractogenic Action of Galactose.* (E. L. Moore, M. D. Henderson and H. S. Mitchell. J. Nutri. **21**, Feb. 1941.) (Department of Chemistry cooperating.) Preliminary work showed that deaminized casein was more protective against galactose cataract in rats than ordinary commercial casein from which it was prepared. Other work has indicated that the type of treatment which alters the growth value of a protein may or may not affect its anti-cataractogenic quality. Hydrolytic products of casein and deaminized casein were prepared by both acid and enzymic hydrolysis and were fractionated by Dakin's method. The whole proteins or the hydrolysates were fed on the basis of the nitrogen equivalent of 10 percent of protein fed as casein. The fractions were fed in amounts proportional to the respective yield of each.

The enzymic hydrolysate of deaminized casein was somewhat more protective than the deaminized casein from which it was prepared. Of the fractions, the diamino-dicarboxylic acid fraction of the enzymic hydrolysate afforded as much protection as the whole hydrolysate, while the monoamino and proline and peptide fractions showed no protection whatever. Blood-sugar determinations indicated that the protective action was exerted in the presence of the high blood sugar and not by a lowering of the blood sugar level.

4. *The Influence of Certain Diamino and Dicarboxylic Amino Acids upon the Cataractogenic Action of Galactose.* (H. S. Mitchell and G. M. Cook.) Following the lead suggested by the work just reported, some individual amino acids are being investigated. Glutamic acid, histidine, and arginine are all present in the protein hydrolysate fraction found to be most protective in the previous work. The amino acids are being fed incorporated in a low-protein galactose ration in order to observe any possible protective action. Results are not yet available.

5. *Time Factors in the Development of Galactose Cataract.* (G. M. Cook and H. S. Mitchell.) It has been observed in this and other laboratories that young rats are more susceptible to galactose injury than older rats. An experiment designed to investigate the question of this age factor is in progress. Rats from the same litter are started on experimental rations at fortnightly intervals. The ones started later require a longer time for lenticular injuries to become evident. The data are not yet complete.

The injury due to galactose seems to persist in rats after they have been transferred to rations containing none of this sugar. The blood sugar returns to normal within a few hours after the ration change is made. The apparent lag in the galactose injury must be due to slow diffusion from eye fluids. The extent of this lag is being investigated by discontinuing the galactose ration at four-day intervals on a series of rats from the same litter.

6. *The Influence of Different Salt Mixtures on the Utilization of Lactose.* (H. S. Mitchell and A. W. Wertz.) Preliminary evidence indicates that the amount and type of mineral elements in a ration may influence the rate of breakdown and absorption of lactose. Two commonly used salt mixtures seem to have slightly different effects. Experiments in progress are designed to study the effect of the type and amount of salt mixture on the growth, blood sugar, diarrhea, and lenticular change of rats fed a 60 percent lactose ration.

DEPARTMENT OF HORTICULTURAL MANUFACTURES

W. W. Chenoweth in Charge

Cranberry Research. (C. R. Fellers and A. S. Levine.) Further study has shown that dextrose can be substituted for approximately one-third of the sucrose in canned cranberry sauce with no loss in quality. This finding should result in savings of about $45,000 on the canned cranberry sauce packed in Massachusetts alone.

Preliminary studies on cranberry seed oil show it to be a bland sweet oil containing approximately 200 U. S. P. units of vitamin A per gram as well as some antirachitic substance. Ursolic acid, a constituent of cranberry skins, was found to be entirely non-toxic to laboratory animals and men. Ursolic acid is a good emulsifying agent and may prove useful in certain food preparations.

Disintegration of cranberry waste (skins and seeds) in a hammer mill gives a finely divided mass which can be put back into the sauce to increase the yield. Since the pulper waste constitutes from 5 to 9 percent of the weight of the cranberries, recovery of this pectinous waste and its use in canned cranberry sauce should prove of marked economic interest. The percentage analysis of the disintegrated pulp showed: protein 11, fat and wax 20.3, nitrogen free extract 38.5, fiber 26.6, ash 2.5, and pectin (alcohol precipitate) 21.7.

Apple Products Including Apple Juice. (C. R. Fellers, A. S. Levine, W. A. Maclinn.) Except for the baking trade, canned apples have not been widely used by the consuming public. In a previous study (*Canning Age,* 20, (No. 2): 68-70, 82 and (No.4): 179-181, 1939), methods are described for packing canned baked or glazed apples. As a result of this study, several canners are now successfully packing this product.

Apple rings or sliced apples in syrup were extensively studied during the past year. In order to obtain good clearing and syrup penetration into the tissues, it was necessary to vacuumize the carefully cooked slices. The sugar hardens the fruit and a very acceptable apple dessert is thus obtained. A 40 percent sugar syrup consisting of 2 parts of sucrose to 1 of dextrose gave excellent results. The canned products retain their color

and flavor very well during storage. The data are published in *Fruit Products Journal* 20 (No. 1) : 5-6, 25, 1940.

Bulletin 336, "Apple Cider and Cider Products" was reprinted, the supply having been entirely exhausted. Considerable time has been given to persons interested in making clarified apple juice, canned apple juice, and fermented cider of the sparkling type. Clear, sparkling bottled ciders containing both 3 and 7 percent alcohol have been prepared in the laboratory. Due to difficulty of control and clarification, it is not recommended that apple growers or small cider pressers attempt to produce cider containing 3 percent alcohol. A study was made of various clarification methods, including the use of pectin-dissolving enzymes and gelatin-tannin solutions. Deaeration of fresh apple juice was not found helpful in retaining the ascorbic acid or in improving flavor. There is some evidence that deaeration decreases can corrosion in canned apple juice.

Fruit Jellies. (C. R. Fellers, A. S. Levine, and F. B. Voit.) Efforts were concentrated on perfecting cider jellies and apple marmalades. Cider jelly was much used in colonial times and was prepared simply by boiling apple juice until it solidified into a tough rubbery mass at concentrations varying from 7 or 8 to 1. Jellies were prepared from cider in several ways such as by concentrating the clarified apple juice to one-half of its volume, adding sufficient sugar to make 50 percent soluble solids, and concentrating further to 68 or 70 percent solids, at which point a jelly is formed. For ciders from some apple varieties, the addition of pectin is necessary. As a suggested home recipe, boil 1 quart of fresh cider to a volume of 1 pint. Add 2 cups of sugar. Boil to a strong jelly test (221° F.). Depending upon the variety and condition of the apples, a little heat-extracted juice from either the fruit or pomace may be added as a source of pectin.

A good jelly of characteristic flavor can also be made from hard cider with the aid of added pectin and sugar. Very little alcohol remains in the finished product.

The base for cider marmalade was apple juice concentrated to 30 percent solids. Sugar was added to bring up the solids to 50 percent, and the temperature raised to 220° F. Thin slices of apple suspended in the jelly before it was poured into glasses cleared well and gave an attractive and tasty marmalade.

Nutritional Studies on Dog Foods. (John Bernotavicz.) A study has been in progress on the use of dried buttermilk powder as the major source of animal protein in a dry dog food. Exactly 50 percent of the animal protein fed was derived from this source. The chemical composition of buttermilk used was 33.72 percent protein, 6.75 percent fat, and 10.20 percent ash. Also present were 85 I. U. of vitamin B_1 per 100 grams and 1950 mgms. of riboflavin per 100 grams of buttermilk powder. The growth-promoting quality of the protein was excellent. The weekly gain in weight of the control dogs fed on a high-grade ration was 0.60 pounds as compared to 0.95 pounds for the animals on experiment. Both groups were fed 40 grams of food per kilo of body weight. Despite the high lactic-acid content of the powder, dogs raised from puppies showed no tendency towards diarrhea. The experimental animals showed a more glossy coat and more subcutaneous fat than the controls.

Work under way, at the present time, on dry dog biscuits shows that 10 percent of the total intake as casein prevents running fits in dogs. On

the other hand, 5 percent of the total intake as canned dog food fails to prevent this condition.

Citrus By-products. (A. Sedky, C. R. Fellers, and W. H. Fitzpatrick.) A new method of making marmalade has been developed in which the orange peel is cooked separately. Retention of as much as 80 percent of the ascorbic acid as well as better flavor and color is made possible by use of this procedure. The time required for the preparation of marmalade may be greatly reduced if concentrated orange juice is used.

Experimental packs of both canned grapefruit sections and juice show that dextrose may successfully replace sucrose as a sweetening agent. In bottled grapefruit juice, the loss of ascorbic acid was proportional to the amount of oxygen present in the juice and container headspace. Thus, deaeration of fruit juices and vacuumization of the filled container are desirable in order to conserve the maximum amount of ascorbic acid in the bottled juice. Flavor is likewise improved.

Red Squill Research. (Cooperative with U. S. Fish and Wildlife Service.) (A. S. Levine and J. A. Lubitz.) Three papers are in press bringing up to date the publication of most of the red squill investigations. These include reports on the toxicity of squill to various animals, the factors affecting toxicity of red squill baits, and the relative values of several volatile oils and imitation food essences as rat lures.

Investigation has been completed to determine the optimum percentage of red squill powder to be used in baits. The more toxic the squill, the smaller the quantity required per bait. Thus, the more toxic squills are the most efficient and therefore more economical although the initial cost may be high at face value.

In a comparison of type of baits, the rats ate corn meal–squill baits in marked preference to poisoned baits made with meat or fish.

Preservative Values of Organic Acids. (A. S. Levine.) Investigations are being conducted to improve the preservation of soda fountain syrups and fruit juices. The present practice of adding citric acid and sodium benzoate is not entirely satisfactory. The substitution of acetic acid (vinegar) for part of the citric acid may lead to better keeping qualities without the need of sodium benzoate. Other organic acids are being studied and compared for their effect on the growth of yeast and molds.

The availability of sodium glycollate medium for the cultivation of anaerobes has made it possible to study the antiseptic effect of organic acids on anaerobic bacteria by the same technique previously employed and reported in similar studies with aerobic microorganisms. These results are needed to develop the theoretical considerations of this project.

Marine Products Research. (C. R. Fellers.) Efforts to can either blue, sand, or rock crabs have always failed. As a result of many years of study, a successful method for the canning of Atlantic crab meat has now been perfected. The method consists essentially in stabilizing the copper present in the hemocyanin of the crab's blood and flesh by means of a protective brine dip containing small amounts of aluminum salts at adjusted pH values.

The canned meat of the blue crab contains about 18 percent of high-quality protein; it is low in fat and high in ash. Particularly notable is

the high content of essential minerals such as calcium, phosphorus, iron, copper, and iodine. The iodine content is from 400-500 parts per billion. The meat contains moderate amounts of thiamin and riboflavin and a small amount of ascorbic acid.

The technique makes possible the establishment of an American crab-canning industry and introduces a new, attractive, tasty, and nutritious seafood to the American consumer. Four commercial canneries are already making use of this new canning procedure.

Research on crab meal for poultry feeding has been started in cooperation with the poultry department.

Carotene Studies. (C. R. Fellers and C. F. Dunker.) A comprehensive literature review and critique on the effect of canning, freezing, dehydration, and storage on the carotene (vitamin A) content of foods has been prepared for the Institute of Food Technologists. Collaborative studies with the U. S. Bureau of Agricultural Chemistry and Engineering on animal assays for vitamin A in frozen and canned peach products were undertaken. Excellent checks were obtained between the chemical methods for carotene and the rat biossay for vitamin A.

Glass Container Research. (C. R. Fellers, K. R. Newman, and W. H. Fitzpatrick.) Extensive experimental work on loss of quality of fruit juices packed in glass containers has been carried on.

As an antioxidant in bottled fruit juices l-ascorbic acid and d-gluco-ascorbic acid are more effective than oat flour, lecithin-dextrose mixture, or tyrosine butyl ester. Thus, any free oxygen present in fruit juice quickly reacts with ascorbic acid and accordingly reduces the vitamin C content of the juice. Heat greatly accelerates the oxygen-ascorbic acid reaction, although the final total loss of ascorbic acid in bottled juices is the same after one or two months' storage, regardless of temperature. However, other quality factors are better retained in fruit juices stored at cool temperatures.

Exposure of bottled juices to artificial light also accelerates the oxygen-ascorbic acid reaction; but again, the total ascorbic acid loss in light and in darkness, over a period of a few weeks, is approximately the same and is never greater than the theoretical loss due to chemical reaction of 100 percent of the oxygen with the necessary weight of ascorbic acid, that is, one molecule of O_2 combines with one molecule of ascorbic acid.

Research on Corn Distillers Dried Grains with Solubles. (C. R. Fellers, R. T. Parkhurst, and K. G. Shea.) This is a cooperative project with Poultry Department. Biological assays showed that this by-product is a very good source of riboflavin and vitamin B_1. While the biological value of the protein to rats is not high, when it was supplemented with casein, fish meal or meat scrap, growth was normal in every respect. For both White Leghorns and Rhode Island Red-Barred Rock hybrids, the distillers grains successfully replaced all the dried skim milk in the New England Conference starting mash at a marked saving in ration cost. Similarly, these grains could also replace about 50 percent of the fish meal plus meat scraps in the Conference Ration. The source of riboflavin and vitamin B_1 was found to be dried yeast cells and lactobacilli. It is estimated that yeast and bacteria comprise about 12 to 15 percent of the weight of the corn distillers dried grains with solubles.

Fruit Juice Concentration. (Lowell R. Tucker.) Fruit juices were concentrated by freezing and centrifuging. Machinery was constructed in cooperation with C. I. Gunness and a method developed for small scale operation at refrigeration plants. The qualities of the fresh juices were changed very little by freezing concentration and subsequent dilution. The degree of concentration that could be obtained without serious loss of soluble solids was often limited by the viscosity of the juices. This limitation was greatest with juices from cooked fruits because of their high viscosities. Highly viscous juices, such as cooked blueberry, currant, peach, and apple, could be concentrated to two-thirds to one-half volume. Less viscous juices, as elderberry, strawberry, and uncooked apple, could be concentrated to one-third to one-fifth volume. Cooked blueberry juice treated with pectinol had its viscosity so thoroughly reduced that it could be efficiently concentrated to 45 percent soluble solids, about one-fifth volume.

DEPARTMENT OF HORTICULTURE

R. A. Van Meter in Charge

Propagation of Hemlock. (Harold S. Tiffany, Waltham.) Tests on the propagation of Canadian hemlock (*Tsuga canadensis*) from cuttings were undertaken (1) to determine the effect of various constant temperatures and certain growth substances on hemlock cuttings, and (2) to secure uniform, own-root stock for fertilization experiments.

Cuttings were made up (Series I on Dec. 5-9, 1939; Series II on Jan. 30-Feb. 1, 1940) in lots of twelve for each of eighteen treatments, duplicated at temperatures of 60°, 65°, 70°, and 75° F. Temperatures were constant, maintained by electric cable and thermostat, with the exception of the 60° bench which fluctuated from 58° to 62° F. Treatments consisted of indoleacetic acid at 15, 25, and 50 mg. per 100 cc. for 16, 24 and 40 hours; indolebutyric acid in the form of Hormodin A (45 and 60 BTI units for 16, 24 and 40 hours); Hormodin Powder No. 3; and no treatment. The cuttings were placed in a medium of half sand and half peat in open benches under cheesecloth tents and kept fairly moist.

Except for slight indications (at 75° and 70° F. only) there were no rootings in check treatments. These initial rootings died before the end of sixteen weeks.

At nine weeks, a single treatment of the December cuttings (Hormodin A. 45 BTI units for 24 hours at 75° F.) showed outstandingly rapid rooting, with a 75 percent showing of fairly massive root systems. The 16-hour lot with this treatment fell to 37 percent, while the 40-hour treatment was 75 percent with less strong root systems. Since increased concentration of this treatment and lower temperature did not raise the percentage of rooting, there is a possibility that a still higher temperature with a lighter concentration would bring a higher percentage of rooting.

At sixteen weeks, 100 percent rooting resulted from thirteen treatments of cuttings in Series II. The most successful rooting (100 percent large root systems) resulted from indoleacetic acid 15 mg. per 100 cc. for 16 hours at 65° F. The percentage of rooting with this treatment fell to 90 at 70° F., and to 80 at 60° F., showing only a fair constancy for the treatment. With 24-hour immersion of the cuttings, however, this treatment

was the most consistent, giving 100 percent rooting at 60°, 65°, and 70° F.

Indoleacetic acid, 25 mg. per 100 cc. for 24 hours, was also consistent, with rootings of 100 percent at 60°, 65°, and 70° F., but with somewhat smaller root systems.

Indolebutyric acid in the form of Hormodin A (60 BTI units for 40 hours) and of Hormodin Powder No. 3 gave 100 percent rooting at 70° F.

In general, the rooting of treated hemlock cuttings was definitely accelerated at higher temperatures, but the percentage of rooting was not as high as that obtained from the same treatment at lower temperatures. In opposition to this trend, a single treatment at 75° F. gave a good percentage of well-developed rooting as early as nine weeks.

Similar trials are planned for the coming season at like temperatures with more varied treatments. Three series of cuttings will be taken from December to late February at five-week intervals.

A series of identical treatments was made with cuttings of Carolina hemlock, *Tsuga Caroliniana,* taken about December 12, 1939.

Only the strongest concentrations of indoleacetic acid solutions brought rootings of over 50 percent, requiring about five months. The response at 75° F. was negligible. At 70° F. a response of 20 to 40 percent was general from most treatments. The highest percentages of rooting came from the following treatments.

Percent of Rooting	*Treatment*
75	25 mg/100 cc Indoleacetic Acid 24 hrs. at 65° F.
58	25 mg/100 cc Indoleacetic Acid 40 hrs. at 65° F.
58	50 mg/100 cc Indoleacetic Acid 40 hrs. at 65° F.
67	50 mg/100 cc Indoleacetic Acid 40 hrs. at 60° F.

Propagation of Lilac. (Harold S. Tiffany, Waltham.) Terminal cuttings were taken on May 28, 1940, of the common lilac, *Syringa vulgaris* var. *Andenken an Ludwig Spaeth,* in lots of 75 for each treatment (except untreated lots with 15 cuttings): (1) Hormodin A solution 40 BTI units for 24 hours: (2) Hormodin Powder No. 3; (3) Formula "66"; and (4) untreated, at each of the constant temperatures, 75°, 70°, and 65° F. and an unheated bench. The medium consisted of two-thirds sand and one-third domestic peat. Cuttings were shaded by cheesecloth tents and lime on the greenhouse glass. Constant temperatures were maintained for the first five weeks only.

At the end of nine weeks the cuttings were potted. A temperature of 70° F. gave the highest percentage of rooting; Hormodin A, 99 percent; Formula "66", 96 percent; the untreated lot, 93 percent. Many of the untreated lot, however, were not sufficiently well rooted for potting. Constant temperature of 75° F. brought but one high percentage of rooting; 92 percent with Hormodin A. In general, rooting percentages mounted fairly constantly from lows with uncontrolled temperature through 70° F., and dropped decidedly at 75° F., because of burning.

All potted cuttings are in good condition with the exception of twenty-seven losses.

Factors Influencing the Hardiness of Evergreens. (Harold S. Tiffany, Waltham.) Plots of *Taxus baccata repandans* and *Taxus canadensis stricta,* set in the spring of 1939, received the first series of cultural treatments this season. Treatments were designed to produce widely varying types

of growth for exposure to winter and artificially controlled temperatures.

A heavy application of nitrate of soda in early May produced early rapid growth. Two applications of stable manure and late cultivation produced late, poorly matured growth. Plants receiving cultivation without fertilizer, showed a somewhat greater average growth than those in sod and also exhibited well-filled textures, while those in sod were excessively straggly and weak in appearance.

Growth measurements were taken representing average maximum terminal growth of from five to twelve plants of each species. A study of the amount of winter injury by (1) leaf count and (2) percentages of dead terminal growth with (3) cross sections of the material under the microscope will furnish indications of the degree to which growth conditions resulting from the different treatments may be related to winter-killing.

Powdery Mildew on Garden Phlox. (Harold S. Tiffany, Waltham.) Control sprays were not applied until mildew (*Erysiphe cichoracearum*) was fairly plentiful on the plantings of *Phlox paniculata*. Materials tested included those used in 1939 and one additional. Again, Hammond's Copper Solution, leaving no residue, and Bordeaux Mixture, leaving a somewhat objectional residue, gave best results. The use of Bordeaux 1-1-50 gave just as good results as the 2-2-50 used in the test in 1939. In 1941 a spray program from early spring to blooming time will be tried.

DEPARTMENT OF OLERICULTURE

Grant B. Snyder in Charge

Variety Studies. (W. H. Lachman and G. B. Snyder.) These studies are conducted in cooperation with the Rhode Island and Connecticut Experiment Stations, to ascertain the influence of the various climatic and edaphic factors upon several strains and varieties of snap beans, celery, cabbage, tomatoes, peppers, and sweet corn. This concludes the third year of a five-year project so the data have not been summarized. Included in the vegetable plantings was Summer Pascal celery, which performed well and was of excellent quality. The Butternut pumpkin of the cushaw group yielded very well and was of high quality.

Shape Index Studies of Tomatoes. (W. H. Lachman.) This work has been continued with eight varieties of tomatoes, to determine the effect of climatic factors in modifying the shape of tomato fruits. Although data have been collected for four years, it is felt that more information is necessary before the results are summarized.

Tomato Breeding. (W. H. Lachman and G. B. Snyder.) The breeding work with tomatoes has been confined to the problem of incorporating the uniform ripening character into varieties which otherwise are very desirable. This has been relatively simple to accomplish because the uniform ripening character is evidently recessive in nature. Many lines have been obtained which are breeding pure for the uniform ripening character; but the self-pollination, which is necessary to obtain pure lines, has caused the selected progenies to segregate for other characters. The main problem now is the selection of lines which are stable for all

characters. The oldest progenies are now in the F_8 generation and some of these appear to offer promise of worthwhile strains.

Sweet Corn Breeding. (W. H. Lachman.) Approximately 200 single plant lines have been selected from the 1600 original lines. The project was started four years ago so that many of the present lines are quite uniform in earliness, productivity, disease resistance, and quality. Many of the inbreds have exceptional vigor in relation to their earliness.

Approximately fifty of the best lines were crossed with an extremely early and productive inbred to study their general usefulness as parental material. Seed has been obtained from these crosses and will be tested in experimental plots during the coming year.

Hybrid Sweet Corn. (W. H. Lachman.) Seventy-one strains and varieties of yellow hybrid sweet corn were planted for trial during the past season. As in previous years many of these performed very well but were a little too late in maturing to qualify as excellent market garden varieties for Massachusetts. Of the varieties which were in the trials four are especially noteworthy: Spancross (C4 x C13) had only a medium-sized ear but was an extra early sort of good quality; Marcross (C6 x C13) was a few days later than Spancross, produced a large ear, and was very uniform in plant and ear characters; Carmelcross (P39 x C13) matured in the early midseason group of varieties, had a large ear, and was of excellent quality; Golden Cross Bantam was especially outstanding in the midseason class, had a large ear, was highly productive, and was of excellent quality. Ioana, which was a few days later than Golden Cross Bantam, produced well-formed ears of fair quality, filled to the tip.

Sources of Organic Matter for Greenhouse Tomatoes. (W. H. Lachman and G. B. Snyder.) Applications of straw, peat moss, cow manure, and horse manure have been made and incorporated in duplicate test plots in the greenhouse in an effort to obtain larger yields of greenhouse tomatoes as well as to ascertain the best source of organic matter. From preliminary observations it appears that peat moss may prove to be a valuable substitute for manure if sufficient commercial fertilizer is applied to compensate for the nutrients which are supplied in the manure. It is planned to repeat the tests several times before a summarized report is made.

The Effects of Mulching Tomatoes and Peppers. (W. H. Lachman and G. B. Snyder.) Various mulching materials were compared with clean cultivation for tomatoes and peppers. Straw, banana fiber, and horse manure were the materials used. Based on one season's results it appears that these mulching materials had little or no effect on the yield, percentage of cracking, or quality of fruit. Banana fiber was apparently quite effective in reducing the acidity of the soil, since these plots averaged approximately pH 7.2 while the pH of the soil from the other plots was about 5.7.

Cultural Practice Prior to Field Setting as Influencing Yield and Quality of Peppers. (W. H. Lachman.) Several methods of handling plants prior to field setting have been used to observe their effect on earliness, yield, and quality of the fruits produced. The Waltham Beauty strain of pepper has been used throughout the test.

Plants grown in clay pots with transplanting solution added produced a greater early yield than plants receiving any of the other treatments. Plants grown in paper pots suffered from nitrogen shortage, but applications of a weak solution of nitrate of soda appeared to correct the deficiency and these plants were among the highest yielders.

The weight of individual fruits was not greater on plots with high yields than on plots with low yields.

The addition of transplanting solutions in most cases increased the yield over the basic treatment. Transplanting solutions appeared to be quite effective in encouraging a quick replacement of roots and in stimulating early plant growth.

This project is being summarized in the Proceedings of the American Society for Horticultural Science.

Asparagus Investigations. (Robert E. Young, Waltham.)

Varietal Improvement. The yield records obtained for over 450 individual asparagus plants in five different lines show that the plants derived from high-yielding parents have greatly outyielded the commercial strain of seed in the trial. This is the first full cutting season for the plots. The two lines that had the greatest yield last year were the best producers again this year.

It was not possible to accurately forecast the relative rank of these lines by comparing last summer's stalk growth. Using the total summer growth for the four years, however, it was possible to forecast the rank in which the six lines would fall in respect to this season's yield. By examining the stalk count of last fall, it was also possible to pick out of all lines those individual plants which were the highest producers this year. This is a confirmation of former results obtained on the older plantings; counts of the stalk growth produced each summer show that, for the four years they have been growing, the plants produced the largest number of stalks the first year. Cutting the plants for two weeks the third year reduced the number of summer stalks remarkably. The full cutting this year did not affect the plants quite so adversely. Apparently they were better established. The variation in yield and stalk growth in any one of the five lines is not as great as that in the commercial seed.

When asparagus is compared with other vegetable crops, it can be readily seen that considerable progress must be made before a variety of asparagus can be established that would be comparable in uniformity of performance to other vegetable crops.

Depth of Planting and Height of Cutting. This project has been completed and the most pertinent results published. Results of practical value to asparagus growers are:

1. Deep planting reduced stand, mostly in the first and second years.
2. Deep plantings were slower to produce in the spring.
3. Asparagus crowns sought the level best suited for their needs. Many of the shallow-rooted plants went down and the deep-planted roots became more shallow. The average for all plots was 4 to 4½ inches from soil level to the top of crown.
4. Cutting the spears with 4 inches of green, which is the length of asparagus tips sold on some of our markets, did not give as high yields per plant as cutting the spears with 8 inches of green, the way most growers cut.
5. Allowing the spears to grow to 12 inches of green increased the yield

slightly but, of course, reduced the number of spears, and would probably bring the grower less returns. The important point in this connection is that cutting the spear with 12 inches of green did not exhaust the plant, as many growers expected. The yield relationships remained about the same throughout the experiment.

The results of this experiment would suggest the following recommendations:

1. Plant crowns 4 to 6 inches deep—shallower on heavier soil.
2. Cut spears with 7 to 8 inches of green for highest returns from the asparagus bed.

Vegetable Breeding for Improvement of Quality. (Robert E. Young, Waltham.)

Lettuce, New York Type. (In cooperation with United States Department of Agriculture.) The breeding work to develop a better adapted lettuce has progressed satisfactorily during the year. The new dark green selections found last year proved to be very desirable. They have dark green color, head well, are very crisp, and have a low percentage of tip burn. The one character that is not satisfactory at present is that most of the heads are not round but slightly flattened. Round-headed selections were made this year in an attempt to remedy this condition.

These selections are still segregating and will not be ready for release for a few more seasons. However, during the last trials, the best selections produced approximately three times as many marketable heads as did the best commercial strain. One further advantage is that most of the crop can be cut at one time.

The necessity of having a large number of selections from the better strains was further emphasized this year. Of the ten selections that were grown from last year's best strain two were of no value, two were only fair, and six showed varying degrees of heading.

Aster yellows, the disease that affected much of last year's crop generally in this section and destroyed 85 percent of the selected plants, was very mild this year. Not over 5 percent of the selections were affected. The reason for the variation in the severity of this disease has not been determined but it probably depends on the number of leafhoppers that live over winter.

Greenhouse Lettuce. The second generation of a cross between Bel-May, our regular greenhouse lettuce, and a dark green English lettuce was produced this year. The segregation of characters of this cross was very favorable to selecting the desired type. Twenty plants were saved and seed produced. It will require several generations to produce a uniform strain.

The supply of stock seed of Bel-May was replenished in the greenhouse under controlled conditions, with the expectation of eliminating the 3 or 4 percent of plants that are dwarf and mosaic-like although the exact nature of this trouble has not been determined.

Celery. Seed of the Summer Pascal celery was readily available and most of the local celery growers tried it. This celery has been generally accepted and is considered a big step forward in the production of a quality crop. Improvement in some of the characters is still needed, and toward this end seed from 20 individuals was grown and carefully noted. Three of this lot were considered superior and further selections were

made. Selected plants were also saved to supply the immediate need for stock seed.

Attempts to speed the breeding program by sending plants to Puerto Rico to to be grown there failed because of heart-burn in the plants which became so severe they died.

Tomatoes. Growers of trellis and greenhouse tomatoes have used and appreciated the two strains of tomatoes (Waltham Forcing and Trellis No. 22) developed at the Field Station. Many have expressed a desire that we continue our work and attempt to remove the two or three undesirable characters they contain. In this connection, crosses were made in the greenhouse using Waltham Forcing, Trellis No. 22, and Early Trellis as one parent and Marglobe, Early Rutgers, and Michigan State Forcing as the other. These hybrids were grown last season in comparison with many strains of Comet of local seedsmen and, of course, the parents of the crosses. The hybrids showed pronounced hybrid vigor, producing more early fruit and a greater total yield. The hybrid vigor was so pronounced, and growers' comments about them so enthusiastic, that an attempt will be made to produce a small amount of hybrid seed for growers' trials. The large percentage of No. 1 fruits produced by our strains of tomatoes was also exhibited by the hybrids. Under intensive cultivation where the value of an acre of tomatoes is very high, the expenditure of $10 to $25 per acre for seed that will increase production from 15 to 25 percent would be within the reach of many of our growers.

Selections were made from the hybrid material to carry on the breeding program as originally started.

Rutabaga or Cape Turnip. The improvement program with Cape turnip was not greatly furthered during the year because the selected turnip plants failed to set seed in the greenhouse, and because what crop was planted outside was almost completely destroyed by cabbage maggot. Seed from other selected roots of the year before will be used for next year's crop.

Hutchinson Carrot. The improvement of the color and core of the Hutchinson carrot by hybridization is becoming more important as local consumers become more accustomed during the winter to carrots from other producing areas. The varieties used in other areas are not suited to our soil and are very susceptible to carrot blight.

The third generation of a cross between the Hutchinson and a Red Turkish carrot was grown this past fall and several lines were selected that were quite uniform and desirable. The biennial nature of carrots makes the breeding program slow.

Selection within the Hutchinson carrot to improve the strain has also been continued.

The supply of stock seed of the Field Station strain of Hutchinson carrot was replenished. The demand for this stock seed has been so great that it has been necessary to limit the quantity to 1½ pounds per seedsman.

Waltham Beauty Pepper. During the year a comparison was made between open-pollinated selections and the same plant self-pollinated in the greenhouse. While the characteristics of the population did not differ greatly and crossing in the field might not be visible, there was no detectable difference in the two lots of seed. Very few of the hybrids have shown the fruit setting ability of the Waltham Beauty and not shown the un-

desirable character of being hard to pick. About 25 lines were grown and many were discarded as undesirable.

Wyman Crosby Beet. The seed crop of this beet, which was to be sent to growers for trial, was almost a failure. As the seed becomes available, it will be put on trial.

Of the 12 self-pollinated lines grown this season, 2 were definitely outstanding as to internal color. Several were discarded because they were too light in color.

A change has been made in the technique of growing and selecting the best beet roots to better show up those specimens lacking in proper color. This different method will also speed up the program through the production of seed in the greenhouse.

Green Sprouting Broccoli. In the spring crop of broccoli 14 selfed, selected plants were compared to the 15 best commercial lines. There has been extreme variation in the time required for broccoli plants to produce a head, but comparing the two groups as a whole there was not much difference in their behavior. At the time of the first cutting, 33 percent of the plants in each group were harvested. In some lines in the selected group, as high as 85 percent of the plants were harvested. In the best commercial line, less than 50 percent of the plants were cut. Three weeks later, at the time of the last cutting, less than 5 percent of the plants in the best selection had not matured a head. This planting demonstrates the need for a better strain, and many selected plants were lifted from the field and self-pollinated.

Some of the same seed used for the spring crop was planted for fall. The best lines in the spring crop were not the best in the fall, indicating the need of two strains for the two seasons. Hybrids have been made between some of the best types and the early, poorly headed types obtained from Italy. Growers have contributed strains on which they have done work, and crosses have been made with these types to provide a redistribution of characters.

Greenhouse Cucumbers. During the year the work with cucumbers has been to collect all the desirable types possible from local growers and seedsmen which were not on hand from last year. These lines were grown in the field and self-pollinated to true up the lines before hybridization work. Mosaic was very severe in the field and only the early fruits were of value. A spring crop was grown in the greenhouse and some of the lines tested. From the vigor and yield of one hybrid under trial, it would seem that hybrid seed which growers could produce themselves would solve the problem of a better cucumber. The work of determining the best parents for such a cross will be continued in the greenhouse and field.

Rhubarb. In an attempt to find a better forcing rhubarb, a collection of varieties has been assembled and preliminary forcing studies made in one of the growers' forcing houses. Some of the strains had better color than Victoria, the variety generally used locally, but most of the strains did not have high yield. Keeping quality after harvest was studied and it was found that wrapping the rhubarb in moisture-proof cellulose sheets prevented deterioration. Further study on the variety problem is needed.

DEPARTMENT OF POMOLOGY

R. A. Van Meter in Charge

The past season was a reasonably favorable one for fruit crops. There was abundant rainfall in the early part of the season but the late summer and early fall were dry with much abnormally cool weather. The apple crop was good considering the heavy crop of 1939. There was some injury to the crop from freezing weather during the latter half of October. Peach buds survived the winter in adequate numbers and there was little cold injury to raspberry canes. Blueberry plants suffered more than usual.

The Influence of Various Clonal Rootstocks on Apple Varieties. (J. K. Shaw and L. Southwick.) Some of the stocks in the stool bed are dying, but Malling II, III, IV, XII, A, and C are still in fair to good condition. A new stock bed was set containing from 25 to 100 each of 21 clonal stocks. A part of the more valuable stocks were set upright for stooling and the rest set on an incline for laying down along the row. No rooted layers will be taken this year but the plants will be cut back in the spring, giving them time to gain vigor before being subjected to cutting.

Some of the cooperative clonal stock orchards are doing very well and others are failures, owing, in some cases, to unfavorable soil conditions and in others to poor management or neglect or perhaps bad luck. One new orchard of about 400 trees was set near Three Rivers.

The clonal stock orchard set in 1937 made excellent growth and a few trees bore good crops. Baldwin grew more on Malling I and IV than on Malling XV and Malling XVI, but Golden Delicious grew more on Malling XVI than on Malling V. Usually trees on semi-dwarfing stocks grow about as rapidly as those on standard stocks but begin to bear earlier, and this checks growth. Trees on very dwarfing stocks may grow less rapidly from the start and are likely to prove useful only in home gardens.

The McIntosh and Wealthy orchard set in 1928 became crowded and most of the Wealthy trees were pulled out, leaving a few scattered trees for pollination. Two plots running across the rows received a hay mulch to see how this affects the trees on different stocks, this treatment having given very favorable results in an adjacent orchard on seedling roots.

The larger orchard of 900 trees, set in 1939, made fair growth and the loss of trees from various orchard ills has thus far been very small. They are being grown under strip cultivation with mulch around the trees. All the Malling stocks in our stock collection, except VI and VII, are represented. The smaller orchard of 55 trees suffered from breakage of the tops and all trees were cut back and made a good whip growth.

A survey of the average growth as measured by trunk diameter fails to show any effect of the dwarfing stocks during the first two years of growth in the orchard. Trees on Malling III and IX have grown more than the same varieties on the "standard" Malling stocks in as many cases as they have grown less. The dwarfing effect will appear at fruiting, and possibly before, with some combinations.

Another interesting observation is that the yearling whips have increased in diameter at least as much as the trees that were two years old at setting, which supports the belief that one-year trees will reach bearing size as soon as two-year trees.

Tree Characters of Fruit Varieties. (J. K. Shaw, A. P. French, O. C. Roberts, and L. Southwick.) This was the twentieth year of nursery examination for trueness to name. A group of 18 nurseries has been visited annually for five years, one of them for all the 20 years. While the number of misnamed trees decreases with repeated examinations, few nurseries escape introducing a few misnamed trees. About the usual number of trees was certified by the Massachusetts Fruit Growers' Association.

The introduction of clonal stocks into the nurseries presents a new problem. Unless the stock is identified before cutting back after budding, it will be difficult or impossible ever to know certainly what stock is under the trees in the orchard. It would be entirely possible to examine the stocks before or after budding and the budded trees the next year and then certify the identity of both stock and scion variety when the trees are ready for sale. Something of this sort should be undertaken or great confusion and uncertainty will arise when and if trees on clonal rootstocks come into use.

The cherry variety nursery of about 45 varieties presented an opportunity for study, and descriptive notes and photographs were secured for publication. All the distinct varieties can be identified in the nursery row.

A pear nursery, including nearly all the varieties found in nurseries in this section of the country, was started. While most pear varieties are rather easily identified, there are a few that require closer study than can be given in nursery visits.

Some study was given to a collection of about 60 peach varieties, and most of them were rebudded for further observation directed toward the difficult problem of identifying peach varieties.

The Genetic Composition of Peaches. (J. S. Bailey and A. P. French.) During the year this project was redirected and rewritten to bring it more in line with work actually in progress. Data obtained during the year indicate that : (1) Genes F (free), M (melting), s (albino), and St (soft melting flesh) are linked in that order, and (2) M is 15 units from F, c 35 units from M, and St 5 units from c.

Comparison of Cultivation and Sod in a Bearing Orchard. (J. K. Shaw.) No change was made in the soil treatment in this orchard, which has been under experiment for 20 years. Additional mulch to a depth of 1 to 2 inches was applied to plot 3 as in the previous two years. The trees are vigorous, with good foliage color and no signs of nitrogen deficiency, despite the fact that no nitrogenous fertilizer has been applied for 20 years. Attempts to harrow in the decaying mulch have not been too successful. Some mixing of the soil and hay has occurred and in this surface layer small rootlets from the apple trees are readily found. This fact is considered to be very significant and may explain in part the surprising apparent response of the trees in growth and fruiting.

Yields and growth of this orchard in 1940 have not yet been compiled, but yield was much lower than the record crop of 1939. As previously mentioned, two additional plots in a younger adjoining orchard were mulched for the first time this year. In all three of these plots, the mulch was applied to cultivated soils reasonably free from grass and weeds. Experience with them suggests that in starting a full mulching program, it may be wise to suppress grass and weeds by cultivation before the mulch is applied.

Determinations of loss on ignition as a measure of organic matter indicate that there is more organic matter in the soil of the sod plots than of the cultivated plots, especially in the 6 to 9 inch level except in cultivated plot 7. This plot is lower and wetter, and therefore the soil is less well aerated and the decomposition of organic matter proceeds more slowly. This determination will be repeated later to measure any changes that may appear.

Comparison of Cultivation and Heavy Mulching for Apples. (J. K. Shaw.) No additonal mulch was applied either to the block of mature Wealthy or to the old McIntosh block now planted to young Wagener and Rhode Island Greening trees. The decaying mulch is now 6 or 8 inches deep and should be sufficient for several years to come even though grasses, mostly quack grass, have grown up through the mulch. The trees continued to grow and produce well, and no injury from mice or fire has yet occurred. Networks of fine fibrous rootlets abound in the upper layer of the soil just below the decaying mulch. Both cultivated plots were fertilized with a nitrogen–potash mixture.

The Effects of Fertilizer Limitation on Fruit Plants. (J. K. Shaw.) The trees planted in 1931 have been removed and the experiment terminated for a time at least. The data await study and evaluation. The general result is that factors other than the fertilizer applications have greatly affected the growth of the trees.

Effect of Potash and Lime on Apple Trees. (J. K. Shaw.) This orchard was pulled out last winter and the experiment ended. The data accumulated in the past 20 years will be studied this winter. The area was seeded to rye in early fall. It is interesting to note that while the addition of phosphorus to nitrogen and potash did not improve the performance of the trees, the presence of phosphorus is the determining factor for good growth of the rye. One corner of the orchard had no fertilizer during the 20-year period, yet the rye grew almost, if not quite, as well as on the nitrogen-only plots. The addition of potash to nitrogen improved growth slightly; but on all plots which had received phosphorus with nitrogen, with potash, or in a complete fertilizer, growth of the rye was excellent.

Study of Varieties of Fruits. (J. K. Shaw and Staff.) The usual observations of the behavior of many of the newer varieties of fruits were made. A new orchard of peach and cherry varieties was set in early May, 1940, on contours on a moderately steep slope. It contains from two to five trees each of 67 new and old varieties.

Apple. Two red variants from the Pacific Northwest have fruited. The Seeando Red Rome this year was much inferior in size and color to Gallia. The latter is often sold as Red Rome but all trees under the name Red Rome may not be Gallia. Shotwell Delicious closely resembles Richared but is possibly a little darker in color.

Stamared is a sport of Stayman, dark red, obscurely striped and splashed. Otherwise, it is like Stayman and the nursery trees cannot be distinguished. It is promising for anyone who wants a highly colored Stayman.

Two varieties from the Prairie Northwest also have fruited. Sharon, of Iowa origin, resembles Duchess in color and has a firm juicy flesh but

little flavor. Haralson has fruited for several years. It is a large round conic apple, lacking in quality. We have elsewhere stated it to be of Iowa origin, whereas it originated in Minnesota.

Four new varieties from Canada have recently begun to bear. Macross is a McIntosh seedling and the tree bears considerable resemblance to that variety. It is a roundish, dark red apple with obscure stripes and splashes. The flesh shows some reddish streaks. It is a little earlier in season than McIntosh, juicy, and of good quality. Hume is another McIntosh seedling of about the same season as Macross. It is dark red, splashed and striped, with a melting flesh of very good quality and a peculiar, rather agreeable flavor. Both of these are promising varieties and worth trying. Edgar is still another seedling of McIntosh crossed with Forest. It is later in season than McIntosh, which it resembles, though somewhat inferior to it in color. The flesh is juicy and good but not equal to McIntosh. Linda is a late winter apple, roundish, of an attractive red color and crisp, juicy flesh.

Cox Orange is a variety well known in England and is grown in Nova Scotia for export to English markets, where it is highly esteemed and brings a high price. The tree is somewhat lacking in vigor but bears fairly well. The apple is rather small, oblate conic, yellow partly covered with a bronze red, and not attractive in appearance. The flesh is subacid, crisp and melting, with a very good, spicy flavor. Perhaps it is not at its best here, but it is easy to see why it is valued by lovers of choice apples. It does not look promising for commercial use but might be desirable for the home garden.

Anoka is from South Dakota, is very hardy, and resembles Duchess. It is remarkable only for its dwarf growth and for coming into bearing very early.

Yates has been grown to see how a variety from the extreme southern apple region would behave here. It proves to be a small, smooth, oblate apple, with conspicuous dots and very poor flavor—an extreme case showing what happens when a variety is grown far from home.

Peach. New varieties of peaches are added to our variety orchards each year. Most of them prove unsuited to our conditions or not superior to established varieties of the same season of ripening. Yet such trials must be made if we are to find the occasional variety that is really an improvement. The following comments on a few varieties are based on one or more years observation in our orchards supplemented with what we have learned of their behavior elsewhere.

Ambergem is a good tough-fleshed clingstone canning peach two to three weeks earlier than Elberta. It is meeting with favor in eastern canning districts; but as we have no canning industry, it will not be planted here.

Candoka is a medium large, round, yellow-fleshed freestone peach of Elberta season or a little later. It is characterized by a red streak down the suture. The flesh is firm melting and of poor quality. It seems to have little or no value for us.

Hardee is a large, compressed, yellow-fleshed freestone peach, a little later than Elberta, unattractive, of poor quality, and of little or no value for us.

Polly resembles Champion closely, ripening a little ahead of it; white-fleshed, soft, freestone of not too good quality—not promising.

Sunglo is said to be an improved South Haven. With us it has shown little superiority, and considering that there are other excellent varieties of this season, it is doubtful whether it finds a place.

Sungold is a large, firm, freestone, yellow-fleshed peach of Elberta season; not very attractive and of only fair quality.

Fruit Bud Formation in the Strawberry. (R. A. Van Meter.) In 1939, twenty plots of 300 plants each, involving four treatments, were established to study the relation of time of mulch removal to the performance of fruit buds. An abnormally late, cold spring tended to eliminate the effects of differential treatments to such an extent that the trial is being repeated.

Twenty plots of 200 plants each were established in 1940. These were given differential treatments as follows:

1. Light mulch to be removed early.
2. Light mulch to be removed late.
3. Heavy mulch to be removed early.
4. Heavy mulch to be removed late.

It is expected that observations on these plants next spring will bring this phase of the study to an end.

Bud Mutations. (J. K. Shaw and W. H. Thies.) The collection of 20 bud selections of McIntosh budded last year served as a source of material for a new project elsewhere outlined. Trees of all 20 lots will be set for orchard observation.

Most of the bud sport selections top-grafted in 1930 have borne fruit. A solid red selection of McIntosh from our own orchards shows no signs of stripes or splashes, but all selections color about equally well. The selections from Wealthy differ very slightly if at all. Among the Baldwin selections, one which produced ill-shaped apples with a tendency to a five-lobed form maintains this character but is of no commercial value.

The most marked variation is among the Gravenstein selections. Scions from a "flat limbed strain", which did not show the malformation up to 1935, now show it, not only in the selected graft but on other branches in the same tree grafted with normal wood. It does not appear on two other top-worked Gravenstein trees in the same orchard. This suggests that this abnormality may be transmissible and possibly caused by a virus. One of the selections of Gravenstein for high color is rather exceptional and is being propagated for comparison with the Washington type now in cultivation. None of the other selections were much superior to the common striped type and some could not be distinguished from it. These observations are in harmony with the belief that Gravenstein more frequently shows bud mutations than other common varieties grown in Massachusetts.

Storage of Apples in Modified Atmospheres. (O. C. Roberts and L. Southwick in cooperation with Engineering Department.) McIntosh apples were stored in 40-quart milk cans from harvest time in 1939 until February 1940. It is probable that the cans were not gas tight, for the oxygen content in no can fell below 8 percent. No attempt was made to remove CO_2 which rose to a maximum of 16 percent with an average varying between about 5 percent and about 12 percent in different cans. McIntosh stored September 25 at 60°-65° F., in roughly 12 percent CO_2

and 10 percent oxygen, were ruined by scald; while others stored at 40° F. came through in excellent condition. Those stored October 11 in a similar atmosphere at 60°-70° F. rotted completely; while those stored at 40° F. were in excellent condition February 1.

Experiments are being continued with the cans tightly sealed by soldering a metal disc in the mouth of the can and metal tubes in the top and bottom for gas sampling and introducing gas for modifying the atmosphere in the can. Different levels of nitrogen, oxygen, and CO_2 will be maintained by controlled respiration, introduction of nitrogen gas, and "scrubbing" to remove CO_2. As the experiment is still in progress, no results can be reported at this time. The oxygen content decreased rapidly after the cans were sealed.

One of our small refrigerated storage rooms was gas-proofed, and 191 bushels of apples, mostly McIntosh but including other commercial varieties, put in the room, which was sealed on October 11. Brine coils on one side of the room made it impossible to fill the room as full as desirable, and the consumption of oxgyen through respiration has been less than hoped. The oxygen has fallen (December 16) only to around 13 percent, while the desired content is 2 percent. Evidently, gas-tight rooms must be filled at least to 80 percent capacity if the oxygen is to be reduced satisfactorily by respiration of the apples. The temperature is kept near 40° F. and apparatus devised for "scrubbing" the storage air to reduce the CO_2 content. The behavior of the apples in the cans, which are absolutely gas-tight and filled to capacity, shows that under these conditions the respiration of the fruit reduces oxygen and builds up CO_2 in a short time. Under the usual conditions of storage, it is impossible to fill a storage room completely full and difficult to make it completely gas-tight.

If storage of McIntosh in a modified atmosphere at higher temperatures than is usual in cold storage works out as investigations elsewhere promise, it will bring about a new situation in our apple industry.

Study of "Bud Sports" of the McIntosh Apple. (J. K. Shaw and L. Southwick.) This is a new project. It is natural to suppose that a type of McIntosh that is uniformly red all over with no sign of stripes and splashes is, in other respects, no different from other types of the variety. Yet it may be inferior in vigor, productiveness, or other respects and be undesirable for orchards in spite of its superior color. This project is planned to learn the truth about this. Six strains of McIntosh, believed to be of distinct origin, have been budded and will be planted in an orchard so planned as to make possible accurate measurements of any differences between the strains that may exist.

Tests of Spray Materials. (O. C. Roberts.) As in previous years, tests of several insecticides and fungicides were made in cooperation with the Departments of Entomology and Botany. A report of the season's work may be found in the report of the Department of Entomology.

Nutrition of the Highbush Blueberry, Especially in Relation to Soil Reaction. (J. S. Bailey.) On January 16, 1940, a series of sand cultures was set up to determine the deficiency symptoms of blueberry plants when various elements are left out of the nutrient solution. This experiment was concluded June 26, 1940. Kodachrome color slides were made of plants, showing the effects of omitting from the nutrient solution N,

P, K, Ca, Mg, or B. One of the most striking results was the reaction of the plants to the acetate ion when it was substituted wholly or in part for the sulfate ion. The plants stopped growing and the leaves became very chlorotic. When the chloride ion was substituted for the acetate ion, the plants partly recovered.

In cooperation with Dr. Linus H. Jones of the Department of Botany, blueberry plants were grown in the soil temperature tanks at 55°, 60°, 65°, 70°, 75°, 80°, 85°, and 90° F. from February 19, 1940, to June 18, 1940. The following results were observed: (1) the plants at the two lower temperatures wilted during the first few days but later recovered; (2) total linear growth and height growth increased as soil temperature increased; (3) plants at 70° F. or higher tended to grow tall and upright; those below 70° F., shorter and more spreading. A report of this work will appear in the **Proceedings of the American Society for Horticultural Science for 1940.**

Blueberry Culture. (J. S. Bailey.) During the winter of 1939–40 there was considerable winter injury to the tops of blueberry bushes in the Experiment Station plantings. Although all varieties were injured to some extent, Rubel was injured much worse than any of the others. The cause of the trouble was probably a dry fall followed by cold, dry, north and northwest winds during the winter. The month of November was unusually dry. There were three weeks with no rain just before the ground froze. A frozen dry soil with cold, dry winds proved to be a bad combination for blueberries.

The Italian ryegrass, planted as a cover crop in 1939, was found to be a mixture of Italian and perennial ryegrass. It made a very good growth in most of the field and consequently furnished considerable organic matter, but it was rather difficult to subdue by cultivation the following spring. A further test of cover crops was started in the summer of 1940. Three special lots of seed were received from the Soil Conservation Service: (1) No. 3297 *Bromus arvensis,* field Brome grass; (2) No. 3197 *Lolium perenne,* perennial ryegrass; and (3) No. 2965 *Phleum pratense,* timothy. These were compared with oats and rye. Good stands of oats and rye were obtained, a fair stand of perennial ryegrass, a poor stand of field Brome, and practically no timothy.

During August, scion wood of the following blueberry selections was received from the U. S. D. A.: DN–76, AW–34, A–91, BM–22, T–72, R–86, L–25, AR–64, X–58, V–20, U–85, V–25, and AW–35. These were budded into Rubel plants in Row A, Plot C.

Plants of the newly named Pemberton variety yielded berries of exceptional size, very attractive appearance, and very good flavor. Berry size held up well throughout the season. The Concord variety bore an unusually large crop of large attractive berries this year.

The blueberry mite was observed for the first time in the College blueberries. It was not abundant and will probably never be a serious pest.

Premature Dropping of McIntosh Apples. (L. Southwick.) Work on this project was reported in Bulletin 372, published in May 1940. The best suggestions that could be made—such as increasing seed number by better pollination, lowering nitrogen in the tree thus decreasing vigor, thinning at the critical time, and spot picking—seemed either impractical or not effective enough. Unfortunate choice of soils favoring drop

cannot be much alleviated though such soils should obviously be avoided in planting new orchards.

In 1939 the use of hormones was suggested and limited trials made that year gave some encouragement that they might have value. In 1940 several commercial preparations carrying these hormones came on the market, and the manufacturers supplied these materials which, with the pure hormone naphthalene acetic acid, were used in more extended tests. The usual concentration was 10 parts per million, but lower concentrations, and in one case a higher concentration, were used. Unsprayed check trees were used in all cases. Comparisons were made in nine orchard blocks on McIntosh, Baldwin, Wealthy, Duchess, and an unknown variety which always drops badly. Drops from each tree were gathered and counted, generally daily, and the numbers of apples picked were calculated. With Duchess and the unknown variety the spray was very effective, holding the apples until past the proper picking time while apples on the checks dropped heavily. With Wealthy and Baldwin the material was not very effective.

Most of the comparisons were on McIntosh, and effectiveness varied in the different tests. It appeared only on computation of the actual percentage of apples dropping. In some cases the effect was very small and in others it was marked, apparently preventing as much as 60 percent of the drop when picking was delayed. The effect appeared first about two or three days after the application and continued around ten to twelve days. About 15 to 35 gallons per tree, according to its size and crop, were applied. Concentrations of less than 10 p.p.m. seemed less effective, suggesting that until further investigation, it is unwise to apply at less than recommended strength.

It is doubtful whether many of the trials on McIntosh checked drop enough to be commercially profitable. It should be remembered that drop was much less in 1940 than usual. It is probable that in a year of normal or excessive drop the use of hormones would be more profitable.

The size of the crop on the trees is perhaps the most important factor in determining the profit from hormone spraying. With a heavy crop the number of bushels saved would be larger while the expense involved would be little more than with a light crop.

Our present feeling is that a McIntosh grower should have a supply of the material on hand and if warm moist weather prevails as harvest approaches, and especially if apples have not sized and colored sufficiently, he should apply it as soon as dropping becomes marked, even if he has to take some of his best pickers for the job. Our experience this year does not warrant any preference for any of the commercial preparations. All are presumed to carry practically the same content of hormone and differ only in the carrier, which may or may not affect the effectiveness of the hormone.

Miscellaneous Work

The Use of Peat in Planting Apple Trees. In May 1939, a small experiment was set up to test the effect of granulated peat on newly set trees. Twenty-six trees (mostly one-year whips) were planted in the usual manner. For an equal number of trees, each tree being paired with a check tree, the soil for planting was thoroughly mixed, 50-50, with twelve quarts of wet peat prior to setting each tree. Several varieties and rootstocks were represented. The peat had been used during one season for propagation purposes and was not strictly comparable to fresh

peat. The paired trees were set between the trees in a newly planted orchard in four locations representing different degrees of soil depth, fertility, and moisture. Pruning was intentionally severe. All trees were cut back to 2–3 feet and the laterals removed.

Neither during the summer of 1939 nor during the summer of 1940 could any consistent differences in growth be detected in the field. Measured by trunk diameter, the check trees apparently have grown as well as the trees planted with peat moss. On three out of the four locations the treated trees grew slightly more but the differences are not significant.

Other work, notably at the New York Agricultural Experiment Station, has shown good results from the use of peat moss at planting time. Peat favored root growth and spur development. Since it is possible that trunk diameter may not accurately reflect total growth, it is planned to make further studies for any possible effects from the peat treatment. Then, too, there is the possibility that peat used in propagation frames for a season may not be as effective as "fresh" peat. There is no doubt that peat favors rooting under many circumstances, perhaps through improved aeration of the soil. Other investigation has shown that the best results are obtained in seasons with excessive soil moisture in the spring followed by drought conditions in midsummer.

It is suggested that as far as planting in Massachusetts is concerned, the natural soil and the site are the important factors. A poor orchard soil is extremely difficult to improve sufficiently for maximum tree performance. The use of peat in the planting operation does not seem necessary on a good soil, though it may prove helpful in some instances.

Soil Acidity in the Orchard. Repeated applications of sulfur sprays and dusts may cause an increase of soil acidity injurious to grass or cover crop and possibly to the trees. Samples of the top three inches of soil were taken from beneath a McIntosh tree growing in sod, which had been sprayed following the current schedules for over 20 years. Lime-sulfur was most used but wettable sulfurs and sulfur dusts have been increasingly used. Results were as follows:

Distance from trunk, feet	*pH Value*
4	4.50
9	4.80
15 (under branch tips)	5.08
20 (midway between trees)	5.60

The steady decrease of pH values, and therefore increase of acidity, towards the trunk is interesting. Probably sulfur sprays tend to run down and drip from the main branches; also when the trees were small, only the more central part of the area was subject to spray drip. The soil near the trunk is ten times as acid as that outside the branch tips and is too acid for many crops. While apple trees are quite tolerant of acid conditions, they may suffer at least indirectly from acid conditions such as these.

Another case of possible soil toxicity in a Sudbury orchard was called to our attention. A visit to the orchard showed that many trees were not vigorous and the grass and weeds under such trees were dead. The line of demarkation under the tips of the branches was sharp. The trees

had been sprayed during this season with cryolite and it was estimated that about two pounds per tree had been applied. Cryolite contains, in addition to fluorine, considerable aluminum. Samples of the top soil were taken under four trees where the herbage was dead, together with check samples taken near by but between the trees where herbage growth was good, also similar samples taken beneath and outside a more vigorous tree with good grass beneath. Determinations of pH value and easily soluble aluminum were made by Professor Everson of the Department of Agronomy. The pH value varied from 3.98 to 4.62 and averaged 4.31; there were no consistent differences between the samples from the different locations. On the other hand, the soluble aluminum was rated as "very high" on all the samples taken where the herbage was dead and only "medium" or "high" in all cases where herbage was good. The pH value 4.50 is considered to be on the border line; below it there is danger and above it less danger of aluminum toxicity. It may be that the addition of aluminum from the spray was enough to increase the aluminum so that a toxic condition prevailed. Of course, a moderately heavy application of lime would correct such a condition.

DEPARTMENT OF POULTRY HUSBANDRY

R. T. Parkhurst in Charge

Broodiness in Poultry. (F. A. Hays.) Efforts are still being made to develop a genetically non-broody line of Rhode Island Reds by selective breeding using aged breeding stock. Birds for breeding are selected not only on their performance record but also on the broody behavior of their daughters.

A recent report on the inheritance of broodiness (Bul. 377) confirmed previous findings that degree of broodiness as measured by the number of broody periods is inherited. This study showed further that deferred broodiness was an important characteristic in dealing with the broody problem. Females exhibiting broody behavior first in the second or third laying year transmitted the broody instinct to about as many daughters as did females that expressed the broody instinct in their first year of laying. Rather definite evidence was presented to indicate the complete absence of sex-linked factors affecting broody behavior in Rhode Island Reds.

Statistical Study of Heredity in Rhode Island Reds. (F. A. Hays and Ruby Sanborn.) This project is devoted entirely to the preparation and analysis of experimental data for publication. During the year the following papers have been prepared: Inheritance of Broodiness in Rhode Island Reds, Station Bulletin 377; Color Markings in Rhode Island Red Chicks as Related to Sex and Adult Color, Jour. Agr. Res. July, 1940; Breeding Small Flocks of Domestic Fowl for High Fecundity, Poult. Sci. 19 (6), 1940; Transmitting Ability in Males of Genes for Egg Size, Poult. Sci. in press; Sex Ratio in Domestic Chickens, Am. Nat. in press; and Correlation in Egg Weight Between Mothers and Daughters, Jour. Hered. in press.

A Genetic Study of Rhode Island Red Color. (F. A. Hays.) Two lines of Rhode Island Reds are being developed in a study of the mode of inheritance of plumage color and the relation of plumage color to char-

acters affecting egg production. One line is bred for early sexual maturity while the other is bred for late sexual maturity. This phase of the project is rather recent, but there is some evidence that the extremely dark shade of plumage demanded in exhibition birds is in part associated with the age at which sexual maturity is attained.

Rate of Feathering in Rhode Island Reds. (F. A. Hays.) The major objective of this experiment is to develop two lines of birds differing with respect to feather development on the back at eight weeks of age. A third line used as a check consists of stock bred for high fecundity with but limited consideration given to rate of chick feathering. Because of a striking sexual dimorphism in the sexes for rate of chick feathering, it is essentially impossible to classify female chicks at any age for rate of feathering on the basis of feather development over the back; therefore, attention has been directed largely to the males.

Line 1 has been sired exclusively through six generations by males with complete back feathering at eight weeks. Line 2 has been sired through the same period entirely by males having no back feathering at eight weeks. The check line was sired by varying proportions of rapid and slow-feathered males. The sixth generation gave the following percentages of rapid-feathering sons in 1940. line 1, 59.0; line 2, 2.2; and the check line, 28.4. Results to date indicate that rapid chick feathering in Rhode Island Reds depends on a series of recessive genes. A sex-linked gene for rapid feathering may be present, but many males having complete back covering may lack this gene. Up to the present time no important differences have been observed in the three lines with respect to characters affecting egg production.

The Effectiveness of Selective Breeding to Reduce Mortality in Rhode Island Reds. (F. A. Hays.) Cooperative project with Regional Poultry Research Laboratory, East Lansing, Michigan. The sixth generation of birds in this project completed their first laying year in the fall of 1940. In the low-mortality line 135 chicks were hatched in this sixth generation and their total mortality to six months of age was 6.6 percent. In the high-mortality line 153 chicks gave a mortality at six months of 10.46 percent. No losses from the paralysis complex were observed.

Forty-four pullets from the low line and forty-six from the high line were placed in the laying houses in September 1939. At the same time all of the brothers of these pullets were housed for the winter. There were 41 males in the low line and 47 males in the high line. Mortality records are complete for 11 months under these conditions. In the low line the mortality in pullets was 47.7 percent and in the high line 21.7 percent. The loss of males in the low line was 14.6 percent compared with 51.1 percent for the high line. For the total population, the losses were 31.8 percent in the low line and 36.6 percent in the high line.

Cannibalism was rather severe in both lines. If the cases of death apparently from cannibalism are omitted, the losses in the high and low lines were: Pullets, 20.4 percent and 13.0 percent; Males, 12.1 percent and 46.8 percent; Sexes combined, 16.4 percent and 30.1 percent. No appearances of diseases of the paralysis complex were observed in either line. The data appear to suggest that the males of the high-mortality line were decidedly less viable than the males of the low-mortality line. Why the losses in the females should fall in reverse order is not clear.

Genetic Laws Covering the Inheritance of High Fecundity in Domestic Fowl. (F. A. Hays and Ruby Sanborn.) Progress is observed in selective breeding of Rhode Island Reds for characters affecting high fecundity. Most of these characters are of rather complex genetic makeup. Early sexual maturity has been well established at a mean of about 190 days when birds are hatched in March and April. Intensity is still variable and the object is to attain a minimum of 3 eggs for winter clutch size. Winter pause has been reduced in duration, and the percentage of birds exhibiting pause has fallen as low as 27 percent. The percentage of broody birds and the degree of broodiness in broody birds have both gone to a low level. Persistency has improved so that the mean is not far below 365 days.

Beginning in 1929, comparisons have been made between the birds in this experiment and four strains from outside sources. From the standpoints of fecundity and of viability no outside strain has proved superior to our experimental strain. Crosses between the high fecundity line and these four strains did not produce superior birds.

Attention is also being given to fertility, hatchability, chick feathering, body weight, egg weight, plumage color, comb type, shank feathering, and inherited factors affecting mortality rate. Progress is being made without sacrificing desirable characters.

A Study of Fertility Cycles in Males. (F. A. Hays.) Records are being collected on the spermatogenesis of males of different ages through the fall, winter, and spring periods. Testicular tissue is being prepared for cytological study to develop some standard for comparing the reproductivity of different males. Particular attention is also being given to possible inherited factors affecting fertility in males. Preliminary data indicate notable differences in the histology of the testis as related to season.

Physiological Relationships Between Molting Behavior and Fecundity Characters. (F. A. Hays.) Bi-weekly records are still being made on the molting behavior of production-bred and exhibition-bred Rhode Island Red males and females. The third series of observations began July 25, 1940, and will be concluded December 26, 1940. The first breeding phase was begun during the spring of 1940 and data will be secured on the molting behavior of this first generation. The stocks available show wide variability in molting behavior, and several important relationships between molting behavior and fecundity are suggested.

Miscellaneous Studies. (F. A. Hays.) Several studies are being carried on under this heading. Rhode Island Reds are being studied for possible linkage relations between genes for shank feathering, genes for comb form, and genes for mottled ear lobe. Differences between Rhode Island Red plumage color and buff plumage color are being studied by hybridization. A method of separating sexes at hatching on the basis of down color is being studied in Rhode Island Reds. For auto-sexing, a type of gold barred bird is being developed.

Manganese Requirement of Rhode Island Reds to Prevent Perosis. (Marie S. Gutowska and Raymond T. Parkhurst.) To determine the threshold level of manganese necessary for the prevention of perosis in Rhode Island Reds, an experiment was conducted with four lots of chicks fed the standard perotic ration, supplemented with commercial ground calcites with and without manganese sulfate, so that the manganese levels

in the rations were 20, 34, 46, and 60 parts per million. Perosis developed in the two lots of chicks receiving the rations with 20 and 34 parts per million of manganese. It was concluded that perosis in Rhode Island Reds can be secured by feeding the perotic ration when its manganese level is not higher than 34 parts per million. The commercial calcites proved to be satisfactory sources of manganese for chicks in the prevention of perosis.

Manganese Absorption in Fowls. (Marie S. Gutowska, with E. M. Parrott and F. S. Slesinski of the Department of Chemistry cooperating.) By the use of the isolated intestinal loop technique, the total amount of manganese absorbed from solutions of $MnSO_4.H_2O$ in 0.9 percent NaCl by Rhode Island Red cocks and hens was found to be proportional to the concentration of manganese in the loop. The percentage absorption of manganese from solutions containing 76, 40, and 10 p.p.m. averaged 35.8, 28.4, and 44 percent, respectively, in two hours. The amount of manganese absorbed per hour per kilogram of body weight in the fowl was relatively small compared with the amount of sugar or phosphorus reported absorbed by rats. Statistical analysis of results indicates that the difference in the absorption of manganese in males and females is not significant.

Manganese was still available for absorption when calcium ($Ca(NO_3)_2$) and phosphorus ($NaH_2PO_4.H_2O$) or (Na_2 glycerophosphate) were placed in the solution in the ratio of 3.91 to 1. An "in vitro" experiment, performed at 41° C., the normal body temperature of the fowl, using the same systems, indicated that practically all the manganese was still present in the solution after the precipitate which formed was filtered off.

A relatively small amount of manganese diffuses from the isolated intestinal loop in dead birds.

The Use of Corn Distillers Grains with Solubles in Poultry Rations. (Raymond T. Parkhurst and F. L. Dickens, with C. R. Fellers of the Department of Horticultural Manufactures cooperating.) Corn distillers dried grains with solubles satisfactorily replaced the dried skimmilk, all the dried skimmilk and fish meal, or all the fish meal and part of the meat scraps in the 1939–1941 New England College Conference laying ration. These substitutions had no effect on egg production, egg weight, body weight, egg quality, or feed efficiency, but lessened hatchability. When the corn distillers dried grains with solubles were used at a 40 percent level in the Conference growing ration, a desirable flushing effect was obtained in young growing birds affected with coccidiosis.

When "complete" laying rations were supplemented with mash, it made no marked difference in egg production, egg weight, body weight, egg quality, feed efficiency, or hatchability whether the mash was moistened with water or supplemented with corn distillers semi-solid grains. Excellent, but approximately the same, results were obtained in the finishing of Rhode Island Red cockerels when the 1939–1941 New England Conference growing ration was supplemented with intermediate cracked corn or equal parts of the corn and corn distillers semi-solid grains with solubles. The birds made an average gain of 3 pounds between 12 and 20 weeks of age.

Factors Affecting Growth, Pigmentation and Feathering in Broilers. (R. T. Parkhurst and Waldon T. Hastings.) Preliminary studies in batteries indicated that good growth, pigmentation, and feathering can be

obtained when the 1939–1941 New England Conference starting mash is used as an all-mash broiler ration. The substitution of 1 percent of liver meal for 1 percent of meat scraps did not improve growth or shank color but gave much better feathering in the pullets. Satisfactory growth but lessened feed efficiency resulted when a partial substitution of fish meal for dried skimmilk was made. When the fish meal ration was supplemented with 5 percent kelp meal, there was no improvement in feathering, shank color, hemoglobin, erythrocyte count, or taste; and feed efficiency was less.

DEPARTMENT OF VETERINARY SCIENCE

J. B. Lentz in Charge

Poultry Disease Control Service. (H. Van Roekel, K. L. Bullis, O. S. Flint, and M. K. Clarke.)

1. *Pullorum-Disease Eradication.* During the 1939-40 testing season there was a marked increase in the volume of testing over the previous year. Flocks were tested on 366 premises: 340 with chickens only, 6 with both chickens and turkeys, and 20 with turkeys only. A total of 689,377 tests was made: 680,663 for pullorum disease, 3,312 for fowl typhoid, and 5,479 for paratyphoid infection. The numbers of samples collected from chickens and fowl other than chickens were 676,611 and 12,776, respectively. Seventy-six reacting birds (66 chickens and 10 turkeys) were necropsied for 40 flock owners.

Testing service was rendered in 12 counties in which 673,222 chicken samples were tested for pullorum disease and only 0.51 percent were positive. No reactors were found among birds tested in 6 counties. All reactors were confined to 5 of the 17 breeds or varieties of fowl tested. Of the total chicken samples tested, 611,099 were from females (78,033 hens and 533,066 pullets) and 62,123 from males, among which 0.5 percent and 0.61 percent respectively were positive. The higher percentage of positive tests among males is attributed to the large number of male reactors in one large flock.

Tests were made of 346 chicken flocks representing 573,000 birds and 3,425 reactors were detected, 3,079 of which were found in 2 large flocks. "Breaks" were observed in 6 previously non-reacting flocks, in 4 of which the origin of infection could not be determined.

Pullorum-disease testing in turkeys has increased from 5,144 tests in 1938-39 to 12,771 in 1939-40. Three infected flocks were detected. Turkey growers are becoming more aware of the seriousness of this disease among turkeys.

Pullorum-disease eradication in Massachusetts is making satisfactory progress. During the past year 280 flocks were 100 percent tested with no reactors and represented 460,045 birds. With this volume of pullorum-free breeding stock, Massachusetts is in a positon to replace its poultry population with pullorum-disease-free chicks.

During the past year this department has continued to cooperate with the Massachusetts Department of Agriculture by making available testing results which are used for official recognition and classification of pullorum-tested flocks.

2. *Diagnostic Service.* Personal delivery of specimens accounted for 405 of the 607 consignments including 3,026 specimens which are classified as

follows: 2,545 chickens; 307 turkeys; 55 pheasants; 29 canine feces; 1[illegible] ducks; 14 rabbits; 10 pigeons; 9 quail; 6 each of canary and mink; 5 each of canine, sheep, and swine; 3 each of bovine semen and bovine skin scrapings; 2 each of bovine feces, canine urine, and feline; 1 each of insects ruffed grouse, and swine abscess.

The incidence of the more common and important disease conditions observed in chicks during the past five years is as follows:

	1935-36	1936-37	1937-38	1938-39	1939-40	Total
Avian tuberculosis		1	1	3	1	6
Coccidiosis	59	35	64	97	82	337
Enterohepatitis	6	2	7	6	7	28
Epidemic tremor	26	8	35	22	19	110
Fowl cholera	3	11	3	16	12	45
Fowl coryza		5	2	1		8
Fowl paralysis	39	37	45	77	47	245
Fowl pox	4	8	30	21	7	70
Fowl typhoid		4	2	11	4	21
Infectious bronchitis	19	40	31	48	57	195
Infectious laryngotracheitis	8	12	9	19	14	62
Internal parasites	21	23	21	41	26	132
Kidney disorders	25	17	15	37	21	115
Leukemia	11	7	3	6	3	30
Nutritional encephalomalacia	10	1	7	13	8	39
Paratyphoid	1	1	2	3	1	8
Perosis	10	4	2	4	3	23
Pullorum disease	44	39	46	49	32	210
Reproductive disorders	12	22	14	20	21	89
Rickets	9	8	6	19	19	61
Tumors	39	53	46	79	53	270
Gizzard erosions		1	15	14	15	45
Unknown disease	15	9	11	24	26	85
Unknown pullet disease	2	6	6	11	9	34

The 307 turkey specimens were received in 57 consignments. Coccidiosis 9, enterohepatitis 12, paratyphoid 14, and rickets 8, accounted for 51.8 percent of the diagnoses. Pullorum disease was noted in only one lot of poults and these were shipped in from out-of-state. That pullorum disease was present in some breeding flocks is indicated, however, by the isolation of *S. pullorum* from 6 of the 10 birds examined bacteriologically following the application of the agglutination test to 3 turkey flocks. A potentially important observation was made when *S. typhi-murium* was isolated from breeding birds over one year of age. Excessive mortality was reported in this flock during the breeding season. Poults from this flock were affected with paratyphoid infection. Fowl typhoid and fowl cholera were not identified in turkeys during the year. Swine erysipelas was identified in one case and ulcerative enteritis in 2 cases. A condition which has been reported to resemble perosis was observed in 2 flocks at about 10 weeks of age. Approximately 10 percent of the birds in one flock were affected.

Among pheasants a cecal infestation with a capillaria species was observed for the first time in this laboratory. We are indebted to members of the Zoological Division, Bureau of Animal Industry, United States

Department of Agriculture, who identified this parasite as *Capillaria caudinflata.*

3. *Flock Mortality Studies.* During the year, 277 morbid and dead birds from the Experimental Poultry Farm were necropsied. Unusual outbreaks of disease were not noted. The birds were hatched during the past five years. Among the birds received from those hatched in the spring of 1939, the largest number of males, 78.4 percent, was submitted from January to May 1940, inclusive; the largest number of females, 73.7 percent, from April to July, inclusive. In this group of birds cannibalism 17, and kidney disorders 14, accounted for 56.4 percent of the diagnoses among the males; and reproductive disorders 74, cannibalism 61, and kidney disorders 20, amounted to 76.3 percent of the diagnoses among the females.

4. *Avian Pox in Ruffed Grouse.* During October 1940, a grouse head was submitted by a person who had shot the bird during the hunting season. It was reported that the bird's flight was abnormal and that excrescences were observed on the eyelids and on the skin posterior to the upper beak. Laboratory examination revealed a suspicion of fowl pox infection. A saline emulsion prepared from the affected tissues and applied to scarified combs and wattles of susceptible chickens produced typical lesions of fowl pox within 8 days after inoculation. The inoculation of pox lesion material from the chickens into pheasants produced evidence of pox infection within 8 days. While pox has been reported in grouse previously by other investigators, this case is of interest to poultrymen and those concerned in upland game bird propagation. Furthermore, this case tends to substantiate the possible reservoir and hosts which may serve as a source of fowl pox infection to poultry, especially on range where direct contact between chickens, grouse, and pheasants is possible.

5. *Salmonella Types Isolated.* Salmonellosis is a disease entity which may occur in a variety of hosts and may be due to many species of organisms in the Salmonella group. The commonly designated paratyphoid organisms in the Salmonella group may cause severe losses. These paratyphoid infections express themselves most frequently among turkey poults, although their incidence among chickens is not to be underestimated.

During the past seven years, 68 strains were typed that had been isolated from specimens received at the laboratory. We are greatly indebted to Dr. Philip Edwards, Department of Animal Pathology, University of Kentucky, Lexington, Kentucky, who identified these strains as to type. The 68 cultures were isolated from the following types of specimens: Mature chickens 4; chicks 16; mature turkeys 3; poults 35; turkey egg 1; mature pigeons 3; and pheasant chicks, ducklings, canary, squab, wild mouse, and commercial rat virus each once. The incidence of the types is as follows: *S. typhi-murium* 47; *S. anatum* 5; *S. bareilly* 3; *S. kentucky* 2; *S. oranienburg* 2; *S. enteritidis* (var. *danysz* and var. *jena*); *S. newport; S. derby; S. newington; S. new brunswick; S. minnesota; S. meleagridis*; and *S. thompson* each once.

During the past year, 17 strains were isolated and identified and all but one (*S. oranienburg*) were typed as *S. typhi-murium.* All of the 17 strains except one were isolated from mature and young turkeys and one turkey egg. Investigational work of a control nature is in progress.

6. *Viability of S. pullorum.* Studies to determine how long *S. pullorum* will remain alive in a dry piece of cloth stored at room temperature showed the organism to be alive after 7 years, 8 months, and 4 days. The last of the cloth prepared for this investigation was examined at the end of a period of 8 years, 3 months, and 8 days and no viable organisms were recovered.

7. *Transmission of Pullorum Disease by Cohabitation.* An attempt to transmit pullorum disease to non-reacting females gave negative results when non-reacting females and reacting males were confined in the same pen over a period of 9 months.

8. *Avian Encephalomyelitis.* Investigations during the past year have further substantiated that mature pheasants appear refractory to the infective agent when inoculated intracerebrally. Pheasant chicks inoculated intracerebrally failed to show definite symptoms, but brain suspensions prepared from these pheasants 76 days after the inoculation revealed that the infective agent was still present and capable of producing the disease in chicks. The virus was not demonstrable in the spleen after this period. Cohabitation of inoculated chicks with susceptible chicks produced positive transmission to the latter. The degree of spread however was slight. Fresh citrated blood obtained from affected chicks was capable of producing the disease in chicks when inoculated intracerebrally, intraperitoneally, and subcutaneously. This was likewise true of liver and spleen tissues inoculated by the intracerebral route. Chicks inoculated by intraperitoneal and subcutaneous routes readily contracted the disease. A group of 309 chicks (consisting of 2 different hatches) were hatched from eggs obtained from a commercial breeding flock whose progeny revealed one outbreak of the disease. The chicks were hatched and reared under control conditions. No evidence of the disease was noted. The infective agent used in some of the above-mentioned experiments is now in its 104th serial passage. Through repeated passage in chicks, the virus acquired a shorter incubation period, a shorter disease course, and a mortality rate of 100 percent.

9. *Farm Department Brucellosis Control and Eradication.* The laboratory cooperated in this work by testing 328 bovine blood samples with the standard tube agglutination method.

Studies of Neoplastic and Neoplastic-like Diseases. (Carl Olson, Jr.) The transmissible lymphoid tumor of the chicken (described previously in Annual Reports for Years Ending November 30, 1938 and 1939) has now been carried through more than 60 serial passages in experimental chickens. The results for the first 30 passages in whch birds received implants of the tumor either in subcutaneous or muscular tissue are summarized in the following table:

Number Inoculated	*Negative*	*Growth*
443	143 (32.3%)	300 (67.7%)

Regression of the growth occurred in 133 of the 300 chickens after it had reached a maximum state of development on an average of 13.6 days after inoculation. No pertinent pathology was observed in these birds at necropsy. The tumor had remained localized and actively growing in 116 of the chickens at the end of their experimental life, which averaged

about 23 days. In several instances the tumor had attained a size of more than 20 percent of the body weight of the host.

Metastasis of the tumor was observed in 51 cases. Metastatic foci of the tumor were found in most of the visceral organs, although they were more commonly noted in the heart, proventriculus, and adrenal glands. In 21 of the cases only a single visceral organ was affected with tumor. One case of diffuse metastasis in the liver, spleen, and bone marrow was noted in the twenty-sixth serial passage of the tumor. Such cases have been encountered frequently in chickens inoculated with material after the forty-fifth passage of the tumor, and the birds die from 9 to 15 days after inoculation. Such a reaction represents a new character of the tumor that has developed due to serial passage.

Fowl paralysis developed in some birds after implants of the tumor (about 3 percent of those inoculated in the first 30 serial passages). There were eight cases (about 5 percent) of fowl paralysis among 151 uninoculated control chickens. The average age when the first symptoms were noted was approximately 72 days in the case of inoculated and 67 days in the case of uninoculated chickens. Therefore, there seems to be no significant association of fowl paralysis with the transmissible lymphoid neoplasm.

Progress has been made on the study and classification of more than 300 cases of spontaneous neoplastic disease in chickens derived from various sources.

Studies of the antigenic composition of blood cells of chickens, discussed in a previous Annual Report (for Year Ending November 30, 1939) have been continued. The results to date may be briefly summarized as follows:

The mating of chickens whose blood cell types were Class I produced progeny with blood cells of the same class. The mating of chickens whose blood cells were of Class II produced progeny with blood cells of the same class. The mating of chickens whose blood cells were Class III produced progeny with blood cells of Classes I, II, and III in the ratio of approximately 1, 1, and 2, respectively. The mating of chickens in which one sex had Class I blood cells and the other sex had Class II blood cells produced progeny with Class III blood cells. These results lead to the tentative conclusion that the genotype of Class I cells is a combination of two dominant genes (AA); Class II cells, of two recessive genes (aa); and Class III cells, of dominant and recessive genes (Aa).

WALTHAM FIELD STATION

(Waltham, Mass.)

Ray M. Koon, in Charge.

The members of the research staff of the Waltham Field Station are assigned to the unit by the Departments of Botany, Entomology, Floriculture, Horticulture, and Vegetable Gardening. Reports of these departments give results of investigations conducted at this station.

Evaluation Gardens. The collection of hardy perennials numbering about 2000 species and varieties has proved to be of definite value to commercial nurserymen and the general public.

Promising new perennials received in the spring of 1940, although not yet tested over winter, include:

Astilbe Fanal (*A. arendsi* var. *Fanal*) bears well-shaped spikes of a clear wine red; a new color in this genus.

Phlox paniculata var. *Eva Foerster*, a dwarf form and vigorous grower, is deserving of particular notice. Its blossoms carry a fine strong pink tone after the salmon tinge of the newly opened florets has disappeared.

Heliopsis patula (Le Moine strain) repeats the fine characteristics of *H. scabra* var. *incomparabilis* with its sturdy, yellow, 3-inch, semi-double late summer blooms. The plants were too young to indicate whether or not this variety extends the bloom season beyond that of *H. scabra* var. *incomparabilis*.

Oenothera glauca var. *Illumination* and *O. fruticosa* var *Yellow River* definitely promise extension of the blooming season for this species.

Clematis: A varietal form of the fragrant tube Clematis (*C. heracleaefolia* var. *davidiana*), available this year under the name Azurea, gave a prolific bloom and greater fragrance than other varietal forms.

Peonies: Among the single Japanese peonies (whose blossoms, being less heavy than double forms, recover from heavy rainstorms rapidly) the following are outstanding: Ama-no-sode, Currant Red, Isani Gidui, Dog Rose, Edward VII, and Tokio.

In order to acquaint the public with the best of the azaleas, plants of the following species and varieties were set out in the spring: *R. arborescens*, *calendulaceum*, *canescens*, *dauricum* var. *mucronulatum*, *japonicum*, *nudiflorum*, *obtusum* var. *kaempferi*, *roseum*, *schlippenbachi*, *yedoense* var. *poukhanense*, *vaseyi*, and *viscosum*. This list, approved by growers of eastern Massachusetts, represents azaleas most successfully grown in this region.

Field Day. The twenty-second annual Field Day on August 7, 1940, attracted over 1300, the largest number of visitors yet recorded. This attendance, in spite of threatening weather early in the day, shows the keen interest of the growers in the work at the Field Station. Eight entries in the new Summer Pascal celery contest demonstrated how widely this variety has been planted in this, its first year in commercial production. Because of the increased interest in machinery, it was necessary to enlarge the area devoted to exhibits.

Soil Testing Service. To most individuals soil tests are of value only when an interpretation of the findings can be made by some qualified person. Such an interpretation must invariably be accompanied by a recommendation for treatment. A total of 6050 samples was tested in 1940, compared with 2704 in 1937.

PUBLICATIONS

Bulletins

336 Apple Cider and Cider Products. By J. A. Clague and C. R. Fellers. 36 pp. July 1940. (A reprint of a bulletin issued first in November 1936.)

Greater care in the application of approved known methods in the production and preservation of apple cider and cider products should make for an enlarged demand for these popular by-products of the fruit industry. This bulletin gives the results of investigations in this field.

369 Annual Report for the Fiscal Year Ending November 30, 1939. 104 pp. February 1940.

The main purpose of this report is to provide an opportunity for presenting in published form, recent results from experimentation in fields or on projects where progress has not been such as to justify the general and definite conclusions necessary to meet the requirements of bulletin or journal.

370 Transmissible Fowl Leukosis. A Review of the Literature. By Carl Olson, Jr. 48 pp. April 1940.

There is considerable uncertainty as to the relationship between the various diseases grouped under the term "fowl leukoses," due partly to the varying results obtained by different investigators and also to the indiscriminate use of terms. This review of the literature was prepared in the hope that it might help to clear up this confusion and thus lead to a better understanding of these diseases—a necessary preliminary to the development of control measures.

371 Cranberry Growing in Massachusetts. By Henry J. Franklin 44 pp. June 1940.

Directions for growing cranberries, from the selection and preparation of the land to the harvesting and marketing of the berries, with photographs illustrating all important points.

372 The McIntosh Drop. By Lawrence Southwick. 19 pp. May 1940.

Among the factors considered, methods of culture which produced the most vigorous growth and heaviest yields also had a tendency to increase drop. Apples with many seeds tended to hang longer than those with fewer seeds. Experiments with several chemical sprays were successful in delaying or preventing drop, but further study is needed to determine whether this method is practical for general orchard use.

373 Foods and Public Health. By James E. Fuller. 16 pp. May 1940.

The aim of this bulletin is to present fundamental information about food-borne diseases in a manner comprehensive yet simple. Only those food-borne diseases are discussed that are important in the every-day life of the average community. Diseases that occur only rarely or not at all in our country are not included.

374 Minerals in Nutrition. 40 pp. August 1940.

Several departments in the Experiment Station have been cooperating in studies designed to add to our knowledge of minerals in foods, particularly the relation of minerals to certain disabling diseases such as arthritis and hardening of the arteries. The following papers are included:

I. Total nutrients and minerals in human and cattle foods.
II. The absorption by food plants of certain chemical elements important in human physiology and nutrition.
III. Possible relationship of Vitamin C and arthritis.
IV. The effect of kelp and mineral supplements on atherosclerosis in rabbits induced by feeding cholesterol.
V. Effect of added iodine on the enzymes of milk and on other enzymes.
VI. Added iodine in milk and fecal bacteria.
VII. Iodine and bacterial counts in milk.

375 Biological Control of Mealybugs in Greenhouses. By W. D. Whitcomb. 22 pp. July 1940.

Laboratory studies demonstrated the possibility of biological control of mealybugs by the use of the imported ladybird beetle, *Cryptolaemus montrouzieri*, Muls., and indicated some of the conditions necessary for success. Tests were then made in greenhouses to determine whether and under what conditions this method of control is practical in commercial practice.

376 The Culture and Forcing of Easter Lilies. By Harold E. White. 20 pp. August 1940.

The culture of Easter lilies for potted plants and cut flowers is an important source of income to Massachusetts florists. The cultural conditions necessary for success with this crop are described and discussed, with special reference to the effect of controlled rooting temperatures on the growth of the lilies.

377 Inheritance of Broodiness in Rhode Island Reds. By F. A. Hays. 11 pp. October 1940.

Breeding tests extending over ten years have led to the following conclusions. Broodiness as measured by the number of broody periods in the first laying year is inherited. Broodiness depends in inheritance on two complementary dominant genes, neither of which appears to be sex-linked. Deferred broodiness greatly retards progress in breeding to eliminate the broody trait, and the complete elimination of broodiness appears to be very unlikely.

Control Bulletins

103 Twentieth Annual Report on Eradication of Pullorum Disease in Massachusetts. By the Poultry Disease Control Laboratory. 13 pp. June 1940.

104 Inspection of Commercial Feedstuffs. By Philip H. Smith. 72 pp. October 1940.

105 Inspection of Commercial Fertilizers. By Philip H. Smith and J. W. Kuzmeski. 49 pp. October 1940.

106 Inspection of Agricultural Lime Products. By Philip H. Smith and J. W. Kuzmeski. 11 pp. October 1940.

107 Seed Inspection. By F. A. McLaughlin. 104 pp. November 1940.

Meteorological Bulletins

613-624, inclusive. Monthly reports giving daily weather records, together with monthly and annual summaries. By C. I. Gunness. 4 pp. each.

Reports of Investigations in Journals

Numbered Contributions

335 Vitamin B_1 and vitamin B_2 (G) content of vegetables as influenced by quick-freezing and canning. By C. R. Fellers, W. B. Esselen, Jr., and G. A. Fitzgerald. Food Res. 5 (5):495-502. 1940.

340 Onion juice and bacterial growth. By James E. Fuller and Ernest E. Higgins. Food Res. 5 (5):503-507. 1940.

342 Coliform bacteria and streptococci in swimming pool water. By Ralph L. France and James E. Fuller. Amer. Jour. Pub. Health 30 (9):1059-1062. 1940.

343 Observations on the development of certain cell-wall constituents of forage plants. By Emmett Bennett. Plant Physiol. 15:327-334. 1940.

345 Effect of benzoated brine dips on keeping quality of fish fillets. By C. R. Fellers and E. W. Harvey. Food Res. 5 (1):1-12. 1940.

351 Pectins and the texture of cooked potatoes. By Monroe E. Freeman and W. S. Ritchie. Food Res. 5(2):167-175. 1940.

352 Action of acetic acid on food spoilage microorganisms. By A. S. Levine and C. R. Fellers. Jour. Bact. 39 (5):499-514. 1940.

353 Canned Atlantic crab meat—A new American food. By Carl R. Fellers and Sterling G. Harris. Indus. and Engin. Chem. 32:592. 1940.

354 Pullorum disease control and eradication. By Henry Van Roekel. Vet. Med. 35 (1): 1940.

356 The grape plume moth. By W. D. Whitcomb and W. E. Tomlinson, Jr. Jour. Econ. Ent. 33 (2):372-374. 1940.

357 Report on Zinc. By E. B. Holland and W. S. Ritchie. Jour. Assoc. Off. Agr. Chem. 23 (2):302-303. 1940.

358 Injury to trees from sulfur dioxide fumes of electric refrigerators. By Malcolm A. McKenzie and Linus H. Jones. Science 91 (2358):239-240. 1940.

359 Spur nitrogen and pre-harvest McIntosh drop. By Lawrence Southwick. Amer. Soc. Hort. Sci. Proc. 37 (1939):435-437. 1940.

360 The depth of planting asparagus and its effect on stand, yield and position of the crown. By Robert E. Young. Amer. Soc. Hort. Sci. Proc. 37 (1939):783-784. 1940.

361 Inhibiting effect of acetic acid upon microorganisms in the presence of sodium chloride and sucrose. By A. S. Levine and C. R. Fellers. Jour. Bact. 40(2):255-269. 1940.

362 Effect of exercise on growth and cataract development of rats fed galactose. By Helen S. Mitchell and Gladys M. Cook. Proc. Soc. Expt. Biol. and Med. 43:85-86. 1940.

363 Phomopsis gardeniae in relation to gardenia culture By Malcolm A. McKenzie, Linus H. Jones, and Constantine J. Gilgut. The Plant Disease Reporter 24 (3):58-62. 1940. (Mimeographed)

364 Breeding small flocks of domestic fowl for high fecundity. By F. A. Hays. Poultry Sci. 19 (6):380-384. 1940.

366 Syrup of cranberry, a new pharmaceutical vehicle. By J. A. Lubitz, C. R. Fellers, and J. A. Clague. Jour. Amer. Pharm. Assoc., Sci. Ed., 29 (7):323-325. 1940.

367 Study practical gardenia canker control as disease increases. By M. A. McKenzie, L. H. Jones, and C. J. Gilgut. The Florists' Review, March 28, 1940.

368 Color markings in Rhode Island Red chicks. By F. A. Hays. Jour. Agr. Res. 61 (1):69-74. 1940.

372 Propagation of white pine by cuttings. By William L. Doran, Robert P. Holdsworth, Arnold D. Rhodes. Jour. Forestry 38 (10):817. 1940.

373 Canned dessert apples. By A. A. McCormack, C. R. Fellers, and W. A. Maclinn. Fruit Prod. Jour. 20 (1):5-6, 25. 1940.

374 Soil as rooting medium for cuttings. By William L. Doran. Amer. Nurseryman 72 (5):7-8. 1940.

378 Grass silage on Massachusetts dairy farms. By Charles R. Creek. 17 pages, mimeographed. August 1940.

382 Vitamin C in packaged foods purchased in retail markets. By K. R. Newman and C. R. Fellers. Jour. Amer. Dietet. Assoc. 16 (7):695-696. 1940.

Unnumbered Contributions

'ut the minerals on the land—not in the manger. By J. G. Archibald. Shorthorn World 25 (19):88. December 25, 1940.

fortality in street tree planting. By Malcolm A. McKenzie. Proc. Mass. Tree Wardens' Ann. Meeting, February 7-8, 1940.

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